FIG. 1

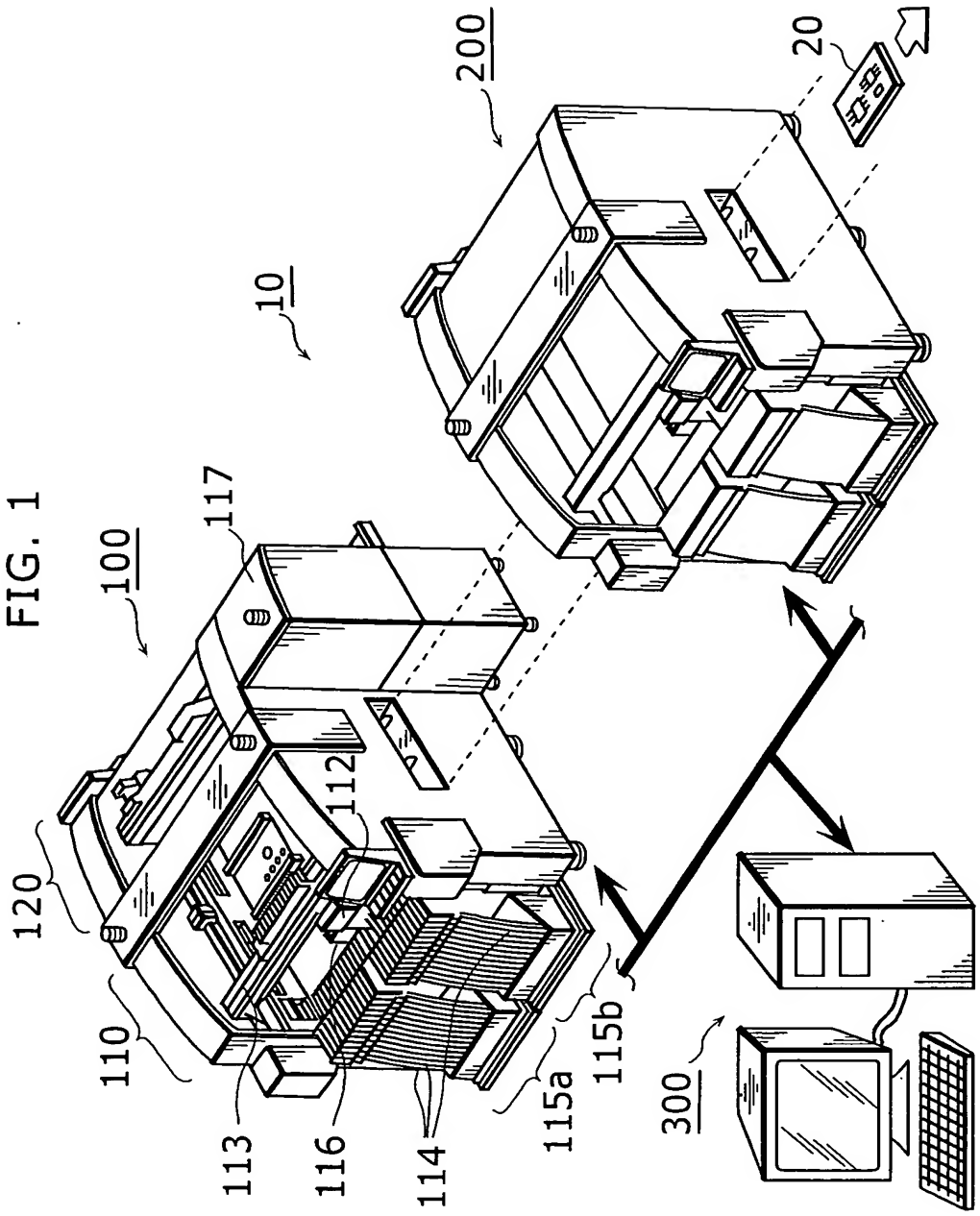


FIG. 2

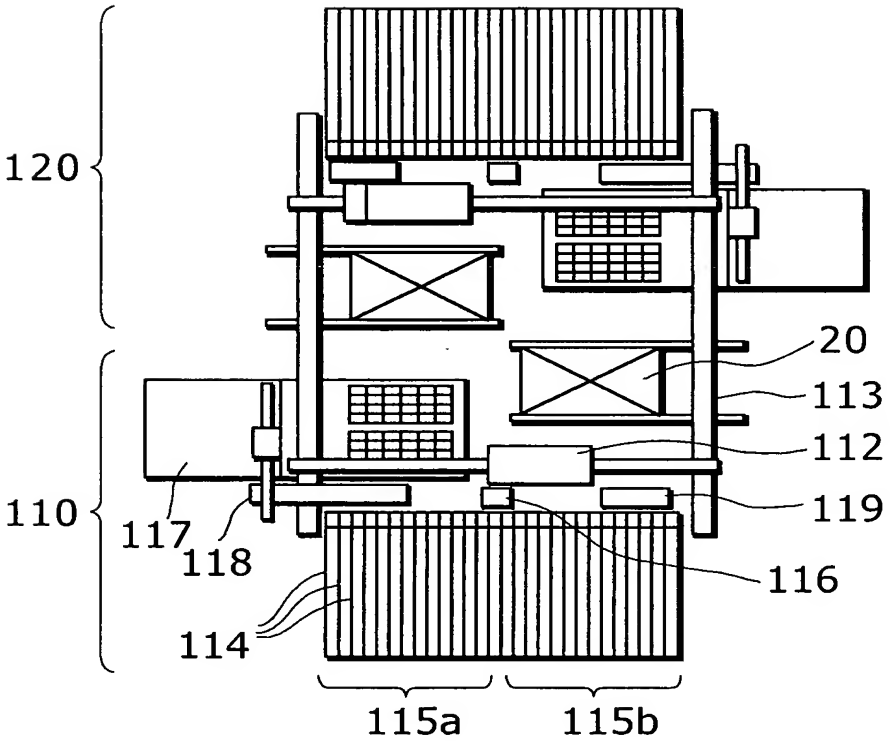


FIG. 3A

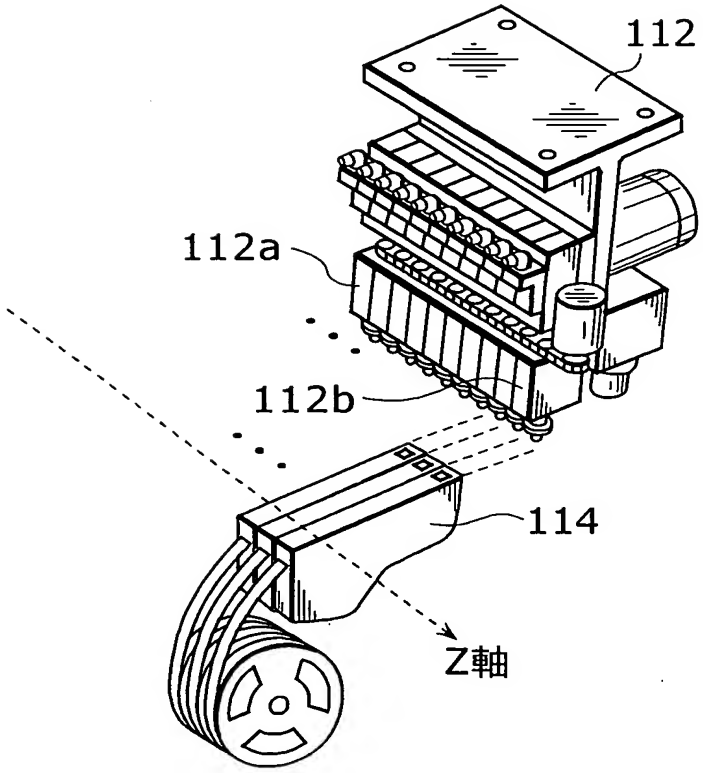



FIG. 3B

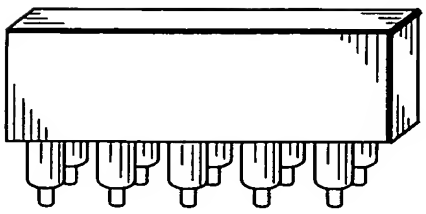


FIG. 4

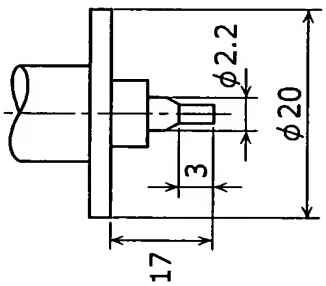
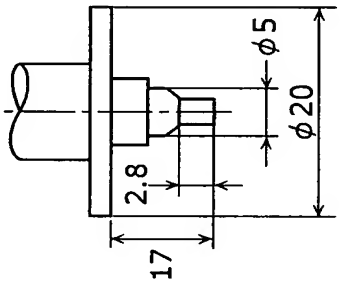
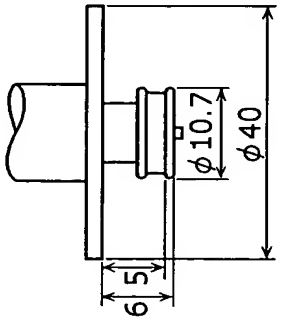
| Type of nozzle | S | M | L |
|---|---|---|---|
| Form of nozzle unit |  |  |  |
| Maximum weight of component | 0.18g | 1.1g | 19g |
| Maximum height of component | 1mm | 13mm | 25mm |

FIG. 5A

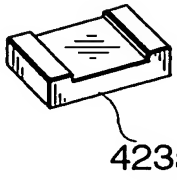



FIG. 5B

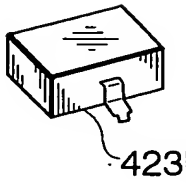



FIG. 5C

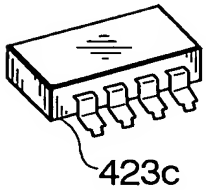



FIG. 5D

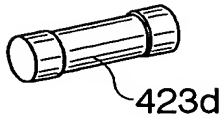



FIG. 5E

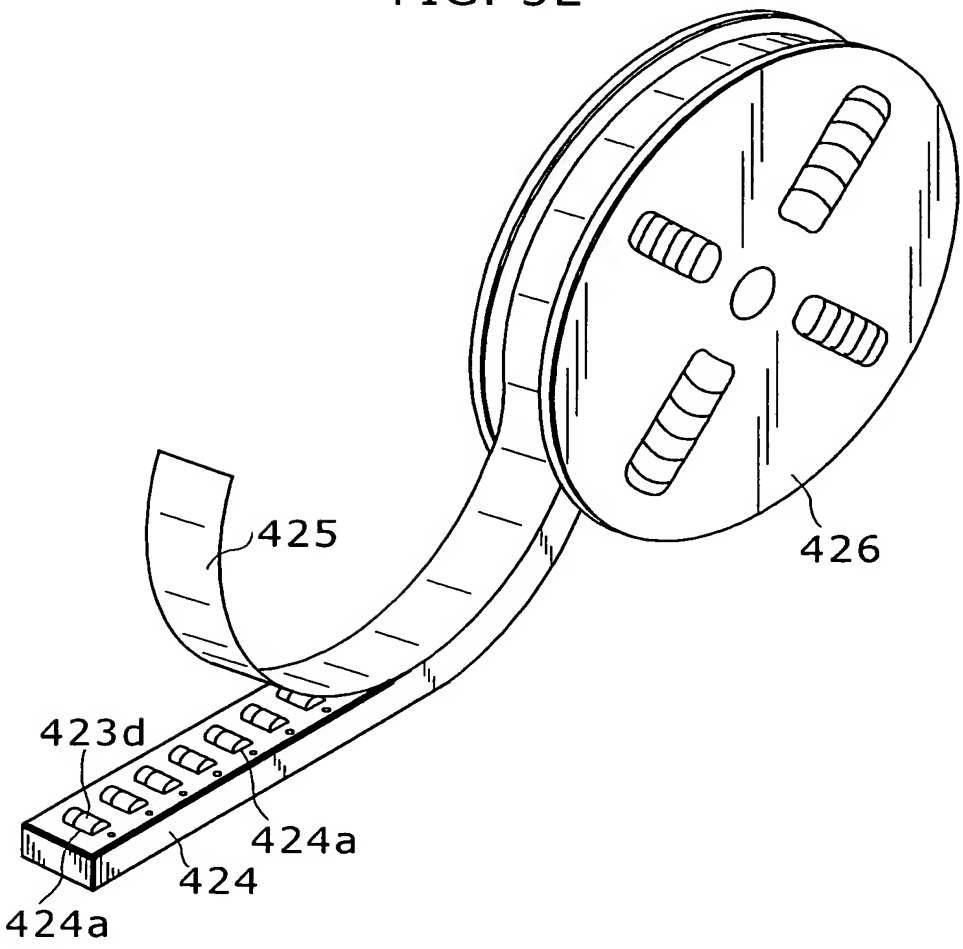


FIG. 6

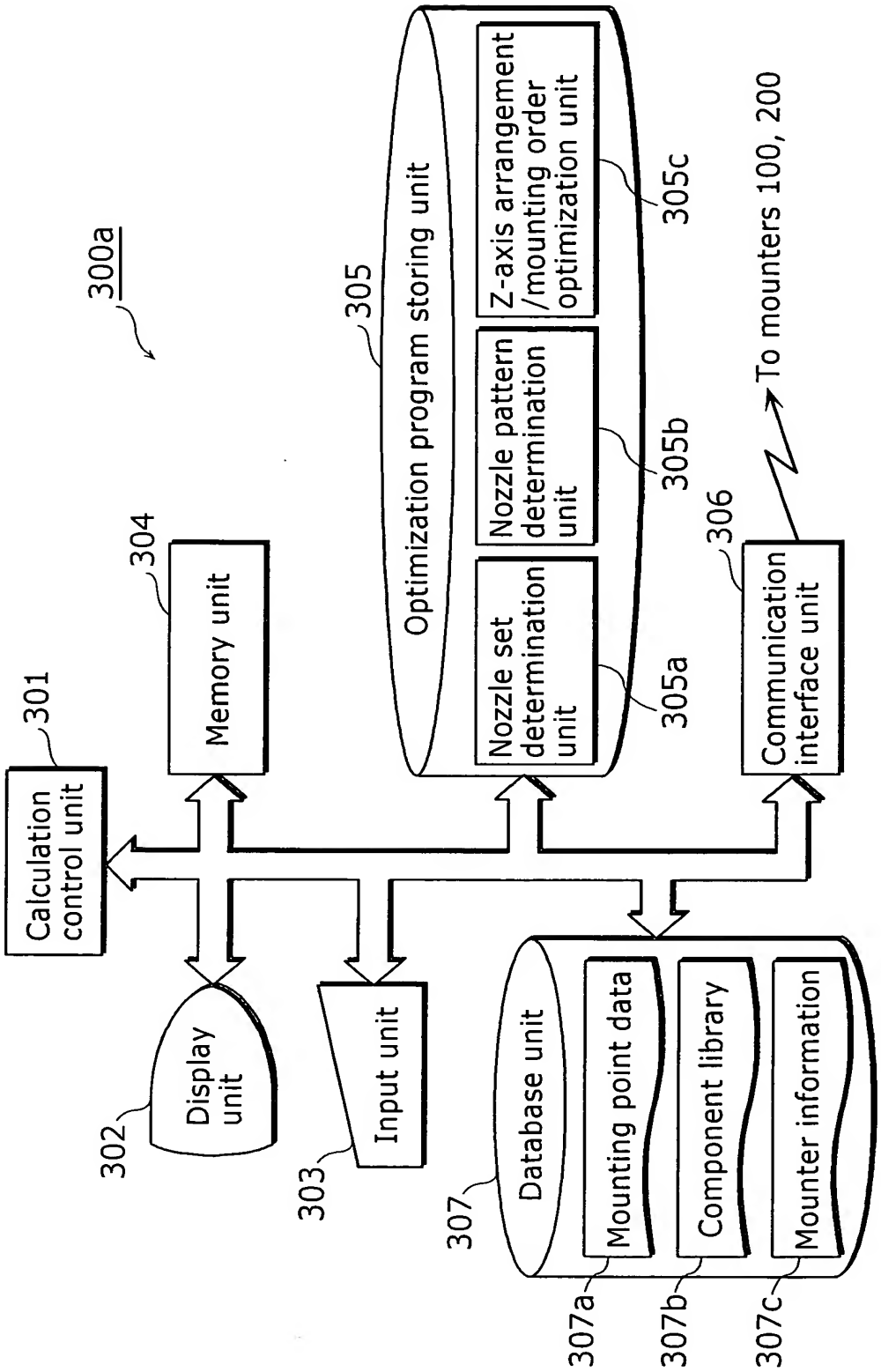

300a
Calculation control unit
301
Memory unit
304
Optimization program storing unit
305
Nozzle set determination unit
305a
Nozzle pattern determination unit
305b
Z-axis arrangement /mounting order optimization unit
305c
Communication interface unit
306
To mounters 100, 200
Display unit
302
Input unit
303
Database unit
307
Mounting point data
307a
Component library
307b
Mounter information
307c

FIG. 7

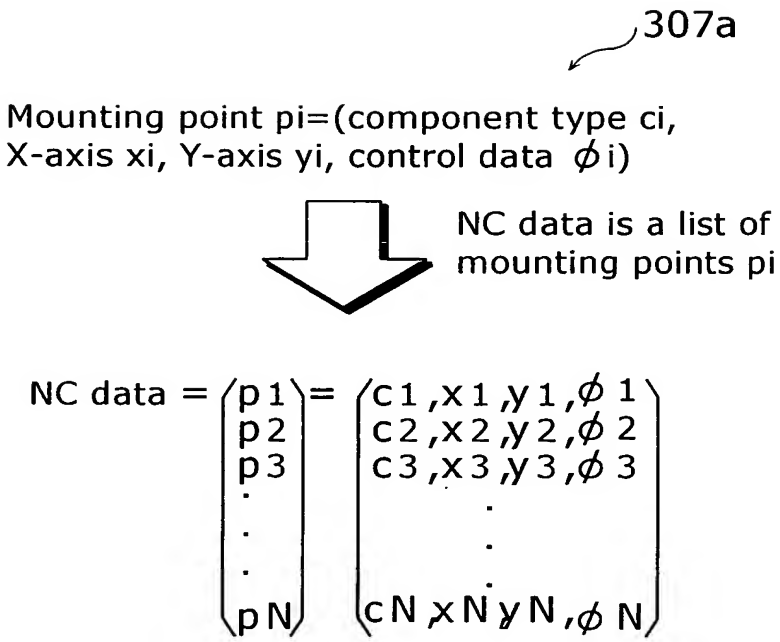

307a
Mounting point pi=(component type ci,
X-axis xi, Y-axis yi, control data φi)
NC data is a list of
mounting points pi
NC data = (p1 p2 p3 . . . pN) = (c1,x1,y1,φ1 c2,x2,y2,φ2 c3,x3,y3,φ3 . . . cN,xN,yN,φN)

FIG. 8

307b

| Name of component | (Appearance) | Size(mm) | | | Two-dimensional recognition method | Pickup nozzle | Tact (second) | Speed XY |
|---|---|---|---|---|---|---|---|---|
| | | X | Y | L | | | | |
| 0603CR |  | 0.6 | 0.3 | 0.25 | Reflection | SX | 0.086 | 1 |
| 1005CR | | 1.0 | 0.5 | 0.3-0.5 | | SA | | |
| 1608CR | | 1.6 | 0.8 | 0.4-0.8 | | S | 0.094 | |
| 2012CR | | 2.0 | 1.25 | 0.4-0.8 | | | | |
| 3216CR | | 3.2 | 1.6 | 0.4-0.8 | | | | |
| 4TR |  | 2.8 | 2.8 | 1.1 | | | 0.11 | |
| 6TR |  | 4.3 | 4.5 | 1.5 | | Cylindrical chip | | |
| 1TIP |  | 2.0 | φ1.0 | - | | | | |
| 2TIP | | 3.6 | φ1.4 | - | | | | |
| 1CAP |  | 3.8 | 1.9 | 1.6 | | S | | |
| 2CAP | | 4.7 | 2.6 | 2.1 | | | | |
| 3CAP | | 6.0 | 3.2 | 2.5 | | M | | 2 |
| 4CAP | | 7.3 | 4.3 | 2.8 | | | | |
| SCAP |  | 4.3 | 4.3 | 6.0 | | | | |
| LCAP | | 6.6 | 6.6 | 6.0 | | | | |
| LLCAP | | 10.3 | 10.3 | 10.5 | | ML | | |
| 1VOL |  | 4.5 | 3.8 | 1.6-2.4 | | M | 0.13 | |
| 2VOL |  | 3.7 | 3.0 | 1.6 | | | | |
| 3VOL |  | 4.8 | 4.0 | 3.0 | | | | |

FIG. 9

307c

| Unit ID | Head information | Nozzle information | Cassette information | Tray information |
|---|---|---|---|---|
| 110 | 10 nozzle heads | SX,SA,··· | 96 | 8 levels |
| 120 | 10 nozzle heads | None | 96 | None |
| 210 | 4 nozzle heads | S,M,··· | 48 | None |
| | | | | |

FIG. 10

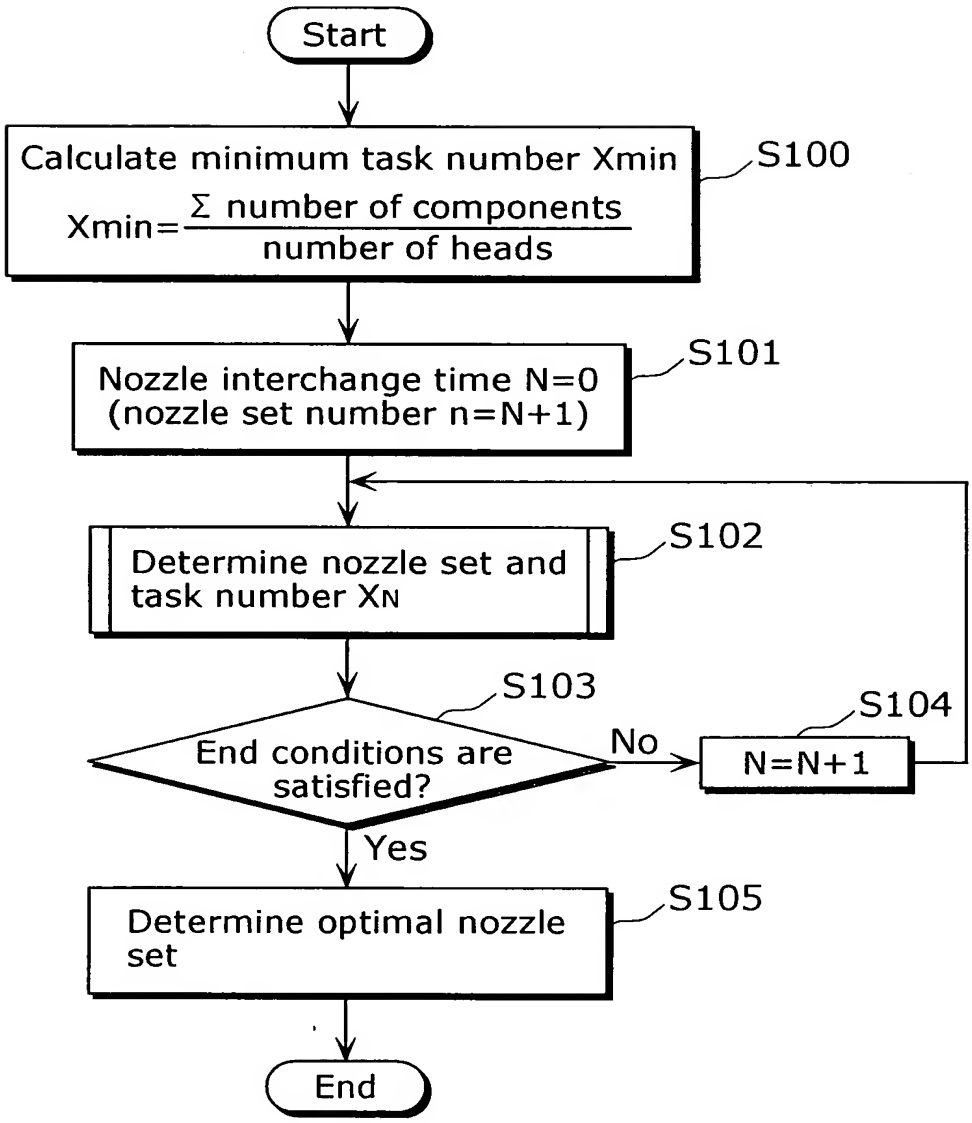

Start
Calculate minimum task number Xmin
Xmin=Σ number of components / number of heads
S100
Nozzle interchange time N=0
(nozzle set number n=N+1)
S101
Determine nozzle set and task number XN
S102
S103
End conditions are satisfied?
No
S104
N=N+1
Yes
Determine optimal nozzle set
S105
End

FIG. 11

| Nozzle interchange time N (nozzle set number n=N+1) | Task number $X_N$ | Evaluated value S |
|---|---|---|
| N=0 | $X_0$ | $S_0$ |
| N=1 | $X_1$ | $S_1$ |
| N=2 | $X_2$ | $S_2$ |
| ⋮ | ⋮ | ⋮ |

Evaluation function:

$S = X_N + h \cdot N$

(h: a coefficient for converting a time taken by interchanging nozzles per time into task number)

FIG. 12

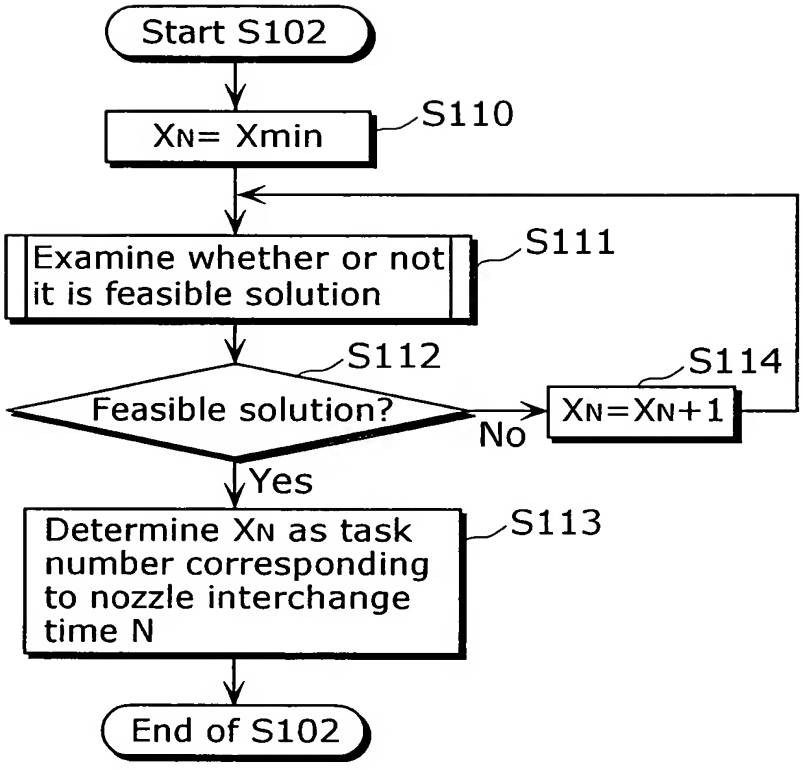

Start S102
XN= Xmin
S110
Examine whether or not it is feasible solution
S111
S112
Feasible solution?
No
S114
XN=XN+1
Yes
Determine XN as task number corresponding to nozzle interchange time N
S113
End of S102

FIG. 13

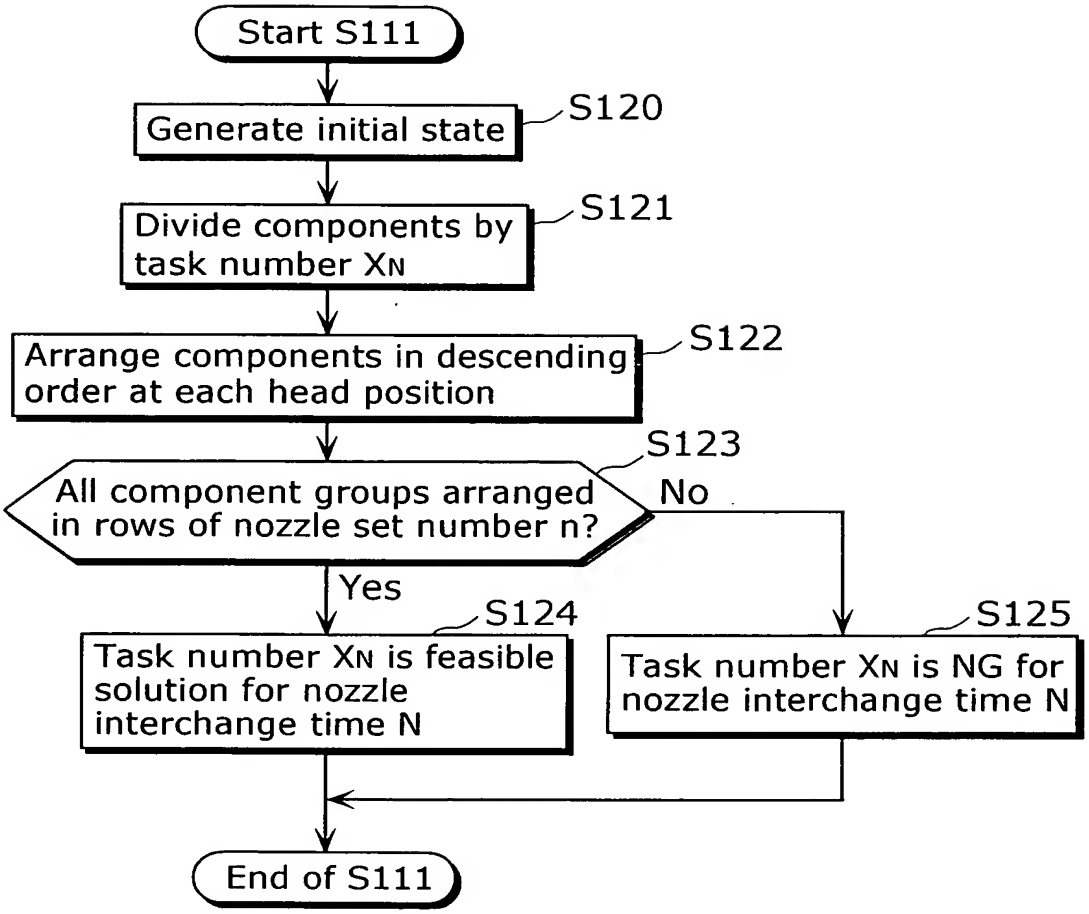

Start S111
Generate initial state
S120
Divide components by task number XN
S121
Arrange components in descending order at each head position
S122
All component groups arranged in rows of nozzle set number n?
S123
No
Yes
Task number XN is feasible solution for nozzle interchange time N
S124
Task number XN is NG for nozzle interchange time N
S125
End of S111

FIG. 14

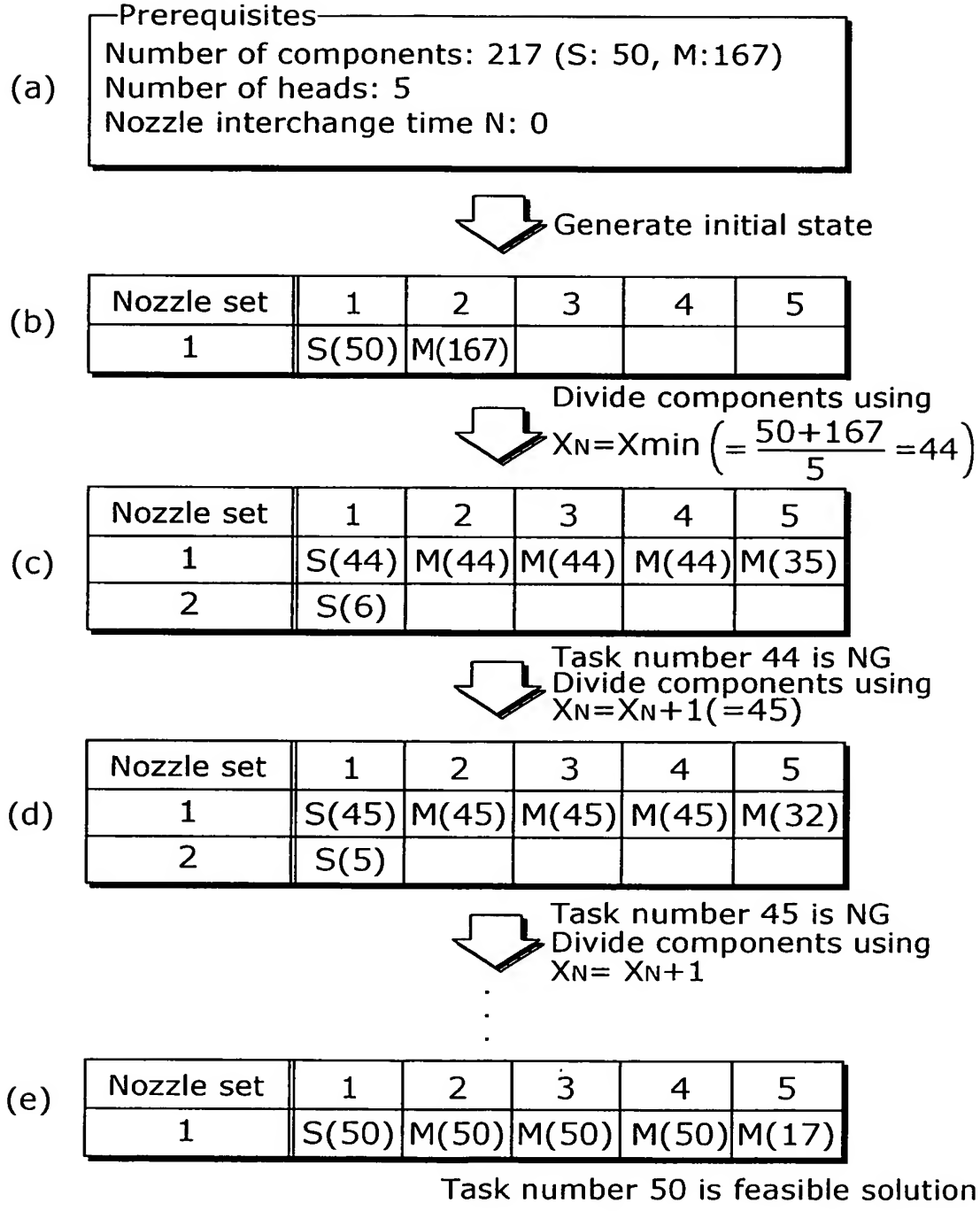

Prerequisites
Number of components: 217 (S: 50, M:167)
Number of heads: 5
Nozzle interchange time N: 0
(a)
Generate initial state
(b)
Nozzle set 1 2 3 4 5
1 S(50) M(167)
Divide components using
XN=Xmin (= 50+167/5 =44)
(c)
Nozzle set 1 2 3 4 5
1 S(44) M(44) M(44) M(44) M(35)
2 S(6)
Task number 44 is NG
Divide components using
XN=XN+1(=45)
(d)
Nozzle set 1 2 3 4 5
1 S(45) M(45) M(45) M(45) M(32)
2 S(5)
Task number 45 is NG
Divide components using
XN= XN+1
(e)
Nozzle set 1 2 3 4 5
1 S(50) M(50) M(50) M(50) M(17)
Task number 50 is feasible solution

FIG. 15

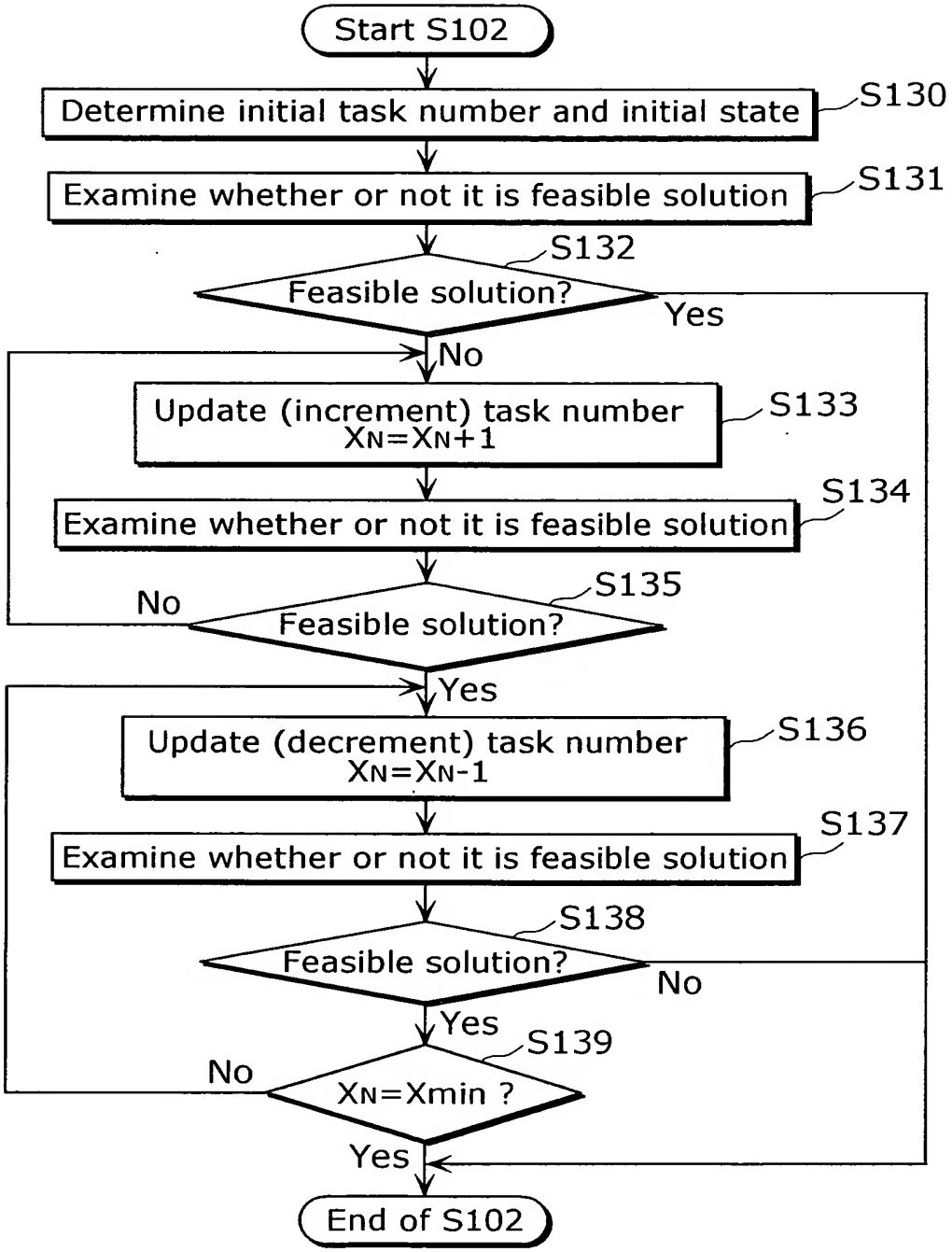
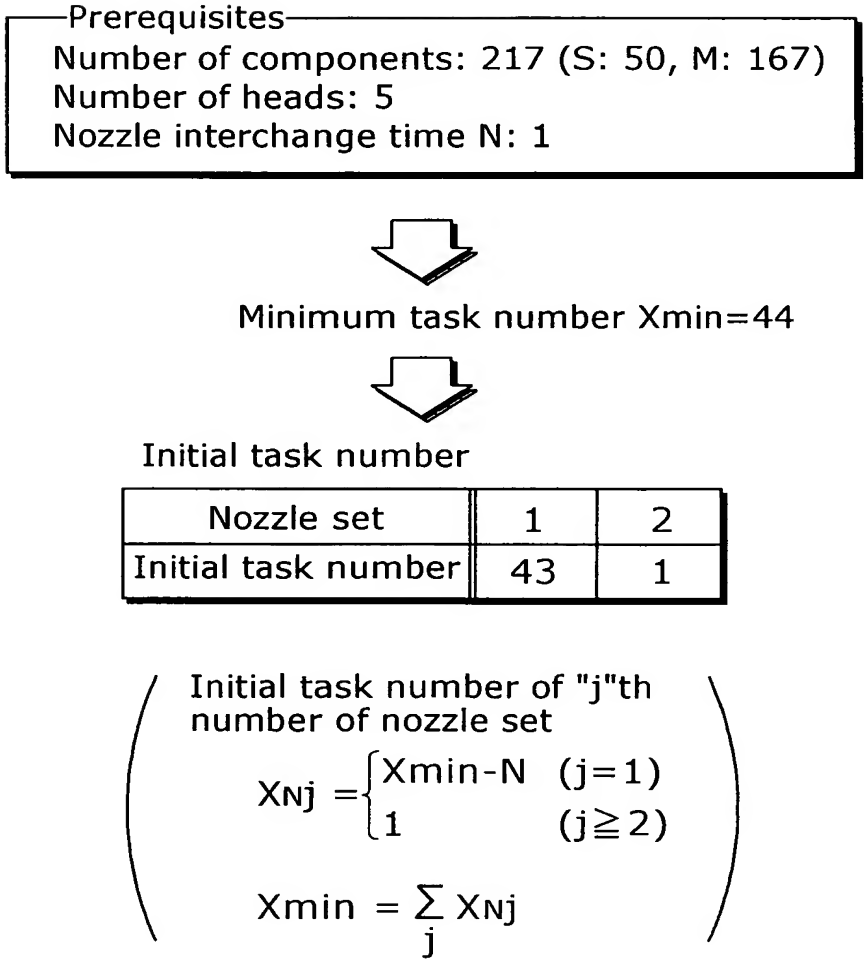

Start S102
Determine initial task number and initial state
S130
Examine whether or not it is feasible solution
S131
S132
Feasible solution?
Yes
No
Update (increment) task number
XN=XN+1
S133
Examine whether or not it is feasible solution
S134
No
S135
Feasible solution?
Yes
Update (decrement) task number
XN=XN-1
S136
Examine whether or not it is feasible solution
S137
S138
Feasible solution?
No
Yes
S139
No
XN=Xmin ?
Yes
End of S102

FIG. 16




| Nozzle set | 1 | 2 |
|---|---|---|
| Initial task number | 43 | 1 |

Initial task number of "j"th number of nozzle set

$$X_{Nj} = \begin{cases} Xmin-N & (j=1) \\ 1 & (j \geqq 2) \end{cases}$$

$$Xmin = \sum_{j} X_{Nj}$$

FIG. 17

(a)

| Nozzle set | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | S(50) | M(167) | | | |
| 2 | | | | | |

Divide components using
$\begin{cases} X_{11}=43 \\ X_{12}=1 \end{cases}$

(b)

| Nozzle set | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | S(43) | M(43) | M(43) | M(43) | M(38) |
| 2 | S(1) | S(1) | S(1) | S(1) | S(1) |
| 3 | S(2) | | | | |

Task number (43, 1) is NG
Update (increment) nozzle set with less "empty head"
Divide components using
$\begin{cases} X_{11}=43 \\ X_{12}=X_{12}+1=2 \end{cases}$

(c)

| Nozzle set | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | S(43) | M(43) | M(43) | M(43) | M(38) |
| 2 | S(2) | S(2) | S(2) | S(1) | |

Task number (43, 2) is feasible solution
Update (decrement) nozzle set with more "empty head"
Divide components using
$\begin{cases} X_{11}=X_{11}-1=42 \\ X_{12}=2 \end{cases}$

(d)

| Nozzle set | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | S(42) | M(42) | M(42) | M(42) | M(41) |
| 2 | S(2) | S(2) | S(2) | S(2) | |

Task number (42, 2) is feasible solution
$X_{min}=\sum_{j} N_j$ is established

End

FIG. 18

Number of components: S(50), M(167)/number of heads:5

| Nozzle interchange time N (Nozzle set number n=N+1) | Task number $X_N$ | Evaluated value S |
|---|---|---|
| N = 0 | 50 | 50 |
| N = 1 | 44 | 46 |

Evaluation function:
$S=X_N+h \cdot N$
(h=2)

FIG. 19

Prerequisites

Component data:

| Nozzle type | Number of components | Nozzle resource |
|---|---|---|
| S | 100 | 2 |
| M | 120 | 2 |

Number of heads: 5
Nozzle interchange time N: 1

Minimum task number Xmin=44

Initial task number

| Nozzle set | 1 | 2 |
|---|---|---|
| Initial task number | 43 | 1 |

FIG. 20

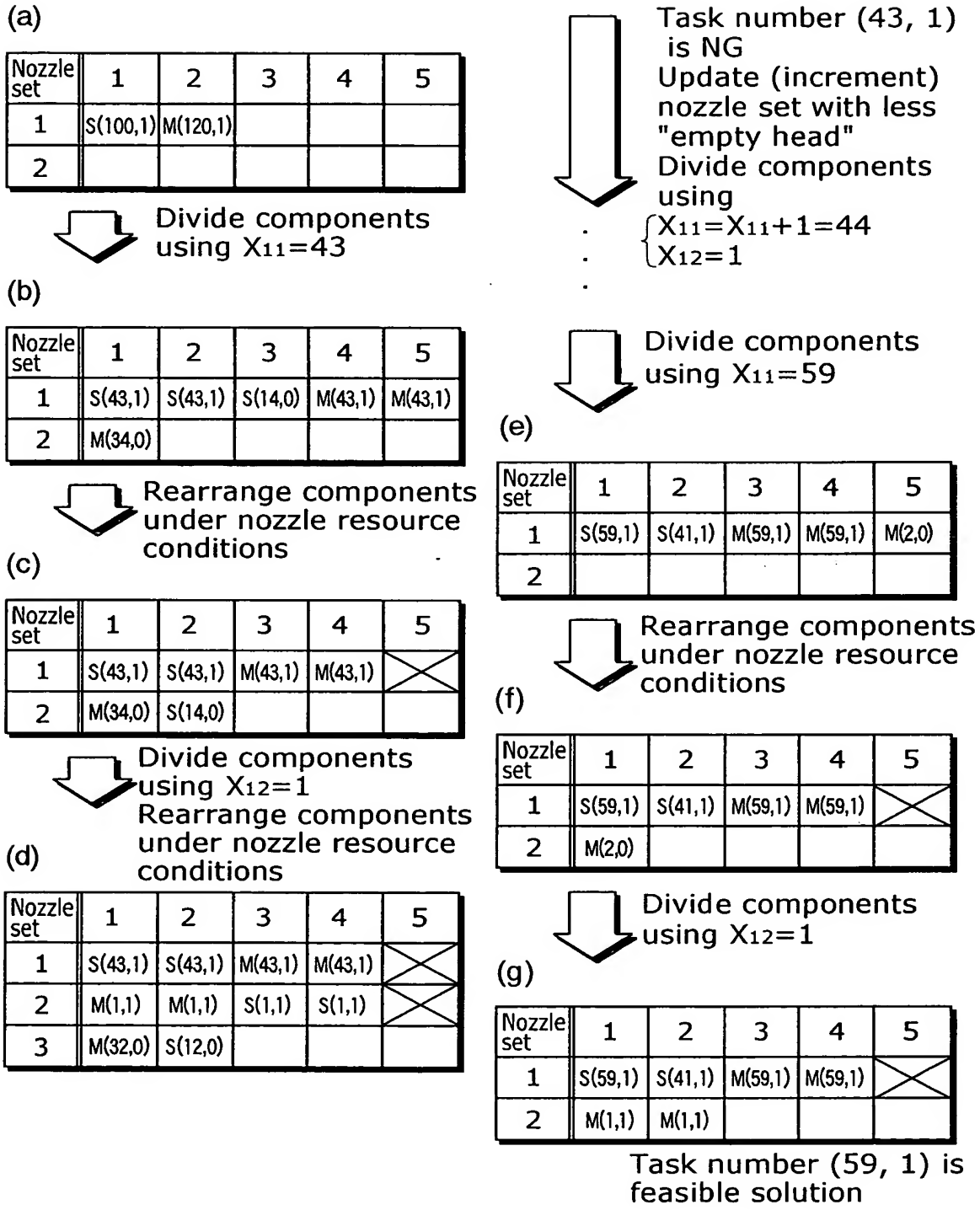

(a)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(100,1) | M(120,1)
2
Divide components using X11=43
(b)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(43,1) | S(43,1) | S(14,0) | M(43,1) | M(43,1)
2 | M(34,0)
Rearrange components under nozzle resource conditions
(c)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(43,1) | S(43,1) | M(43,1) | M(43,1)
2 | M(34,0) | S(14,0)
Divide components using X12=1
Rearrange components under nozzle resource conditions
(d)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(43,1) | S(43,1) | M(43,1) | M(43,1)
2 | M(1,1) | M(1,1) | S(1,1) | S(1,1)
3 | M(32,0) | S(12,0)
Task number (43, 1) is NG
Update (increment) nozzle set with less "empty head"
Divide components using
X11=X11+1=44
X12=1
Divide components using X11=59
(e)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(59,1) | S(41,1) | M(59,1) | M(59,1) | M(2,0)
2
Rearrange components under nozzle resource conditions
(f)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(59,1) | S(41,1) | M(59,1) | M(59,1)
2 | M(2,0)
Divide components using X12=1
(g)
Nozzle set | 1 | 2 | 3 | 4 | 5
1 | S(59,1) | S(41,1) | M(59,1) | M(59,1)
2 | M(1,1) | M(1,1)
Task number (59, 1) is feasible solution

FIG. 21A Number of components:1(224), 2(2)

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(21) | 1(21) | 1(21) | 1(21) | Strict solution |
| 2 | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | (Task number:23) |
| 1 | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | 1(22) | Embodiment |
| 2 | 1(1) | 1(1) | 1(1) | 1(1) | 2(1) | 2(1) | | | | | (Task number:23) |

FIG. 21B Number of components:1(101), 2(32), 3(4), 4(18), 5(2)

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1(14) | 2(14) | 1(14) | 1(14) | 2(14) | 1(14) | 1(14) | 4(14) | 1(14) | 1(11) | Strict solution |
| 2 | 5(2) | 2(2) | 2(2) | 4(2) | 4(2) | 3(2) | 1(1) | 1(1) | 1(1) | 3(2) | (Task number:16) |
| 1 | 1(14) | 1(14) | 1(14) | 1(14) | 1(14) | 1(14) | 1(14) | 4(14) | 2(14) | 2(14) | Embodiment |
| 2 | 1(2) | 5(2) | 2(2) | 2(2) | 3(2) | 3(2) | 4(2) | 4(2) | 1(1) | | (Task number:16) |

FIG. 21C Number of components:1(50), 2(167)

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1(21) | 1(21) | 2(21) | 2(21) | 2(21) | 2(21) | 2(21) | 2(21) | 1(21) | 2(18) | Strict solution |
| 2 | 1(1) | 1(1) | 2(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 2(1) | 1(1) | (Task number:22) |
| 1 | 1(21) | 1(21) | 2(21) | 2(21) | 2(21) | 2(21) | 2(21) | 2(21) | 2(21) | 2(20) | Embodiment |
| 2 | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | 1(1) | | | (Task number:22) |

FIG. 21D Number of components:1(5), 2(34), 3(2), 4(2)

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2(5) | 2(5) | 1(5) | 2(5) | 2(5) | 2(5) | 2(5) | 2(4) | 4(2) | 3(2) | Strict solution |
| 1 | 1(5) | 2(5) | 2(5) | 2(5) | 2(5) | 2(5) | 2(5) | 2(4) | 3(2) | 4(2) | (Task number:5) |
| | | | | | | | | | | | Embodiment |
| | | | | | | | | | | | (Task number:5) |

FIG. 22A Numberofcomponents:1(50),2(10),3(650),4(50),5(50),6(200),7(20),8(215),9(15)

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3(325) | 3(325) | 8(215) | 6(200) | 1(50) | 5(50) | 4(50) | 7(20) | 9(15) | 2(10) |
| 1 | 3(325) | 3(325) | 8(215) | 6(200) | 1(50) | 5(50) | 4(50) | 7(20) | 9(15) | 2(10) |

Embodiment (Tasknumber:325)

Strict solution (Tasknumber:325)

FIG. 22B

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8(111) | 3(111) | 3(111) | 3(111) | 3(111) | 3(111) | 6(111) | 8(104) | 3(95) | 6(89) |
| 2 | 1(25) | 1(25) | 5(25) | 4(25) | 4(25) | 5(25) | 7(20) | 9(15) | 2(10) | |
| 1 | 8(108) | 3(108) | 3(108) | 3(108) | 3(108) | 3(108) | 3(108) | 6(108) | 8(107) | 6(92) |
| 2 | 1(25) | 1(25) | 5(25) | 4(25) | 4(25) | 5(25) | 7(20) | 9(15) | 2(10) | 3(2) |

Embodiment (Tasknumber:136)

Strict solution (Tasknumber:133)

FIG. 22C

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8(106) | 3(106) | 3(106) | 3(106) | 3(106) | 3(106) | 3(106) | 1(21) | 1(21) | 1(21) |
| 2 | 1(18) | 1(18) | 7(18) | 4(18) | 4(18) | 5(18) | 5(18) | 9(15) | 1(14) | 3(14) |
| 3 | 2(5) | 2(5) | 4(5) | 4(5) | 5(5) | 5(5) | 4(4) | 5(4) | 8(3) | 7(2) |
| 1 | 8(67) | 3(67) | 3(67) | 3(67) | 3(67) | 3(67) | 3(67) | 3(67) | 3(67) | 3(67) |
| 2 | 1(50) | 8(50) | 4(50) | 5(50) | 5(50) | 6(50) | 6(50) | 6(50) | 8(50) | 8(48) |
| 3 | 2(10) | 3(10) | 3(10) | 3(10) | 3(10) | 9(10) | 7(10) | 7(10) | 3(7) | 9(5) |

Embodiment (Tasknumber:129)

Strict solution (Tasknumber:127)

FIG. 22D

| Nozzle set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8(101) | 3(101) | 3(101) | 3(101) | 3(101) | 3(101) | 3(101) | 6(101) | 8(101) | 6(99) |
| 2 | 1(17) | 1(17) | 7(17) | 3(17) | 3(17) | 4(17) | 4(17) | 5(17) | 5(17) | 1(16) |
| 3 | 2(7) | 9(7) | 3(7) | 4(7) | 4(7) | 5(7) | 5(7) | 8(7) | 9(7) | 8(6) |
| 4 | 2(2) | 7(2) | 3(2) | 4(2) | 5(2) | 2(1) | 3(1) | 7(1) | 9(1) | |
| 1 | 8(95) | 3(95) | 3(95) | 3(95) | 3(95) | 3(95) | 3(95) | 8(95) | 6(95) | 6(95) |
| 2 | 1(25) | 1(25) | 8(25) | 3(25) | 3(25) | 3(25) | 4(25) | 4(25) | 5(25) | 5(25) |
| 3 | 2(5) | 2(5) | 3(5) | 6(5) | 6(5) | 7(5) | 7(5) | 7(5) | 7(5) | 9(5) |
| 4 | 9(1) | 9(1) | 9(1) | 9(1) | 9(1) | 9(1) | 9(1) | 9(1) | 9(1) | 9(1) |

Embodiment (Tasknumber:127)

Strict solution (Tasknumber:126)

FIG. 23

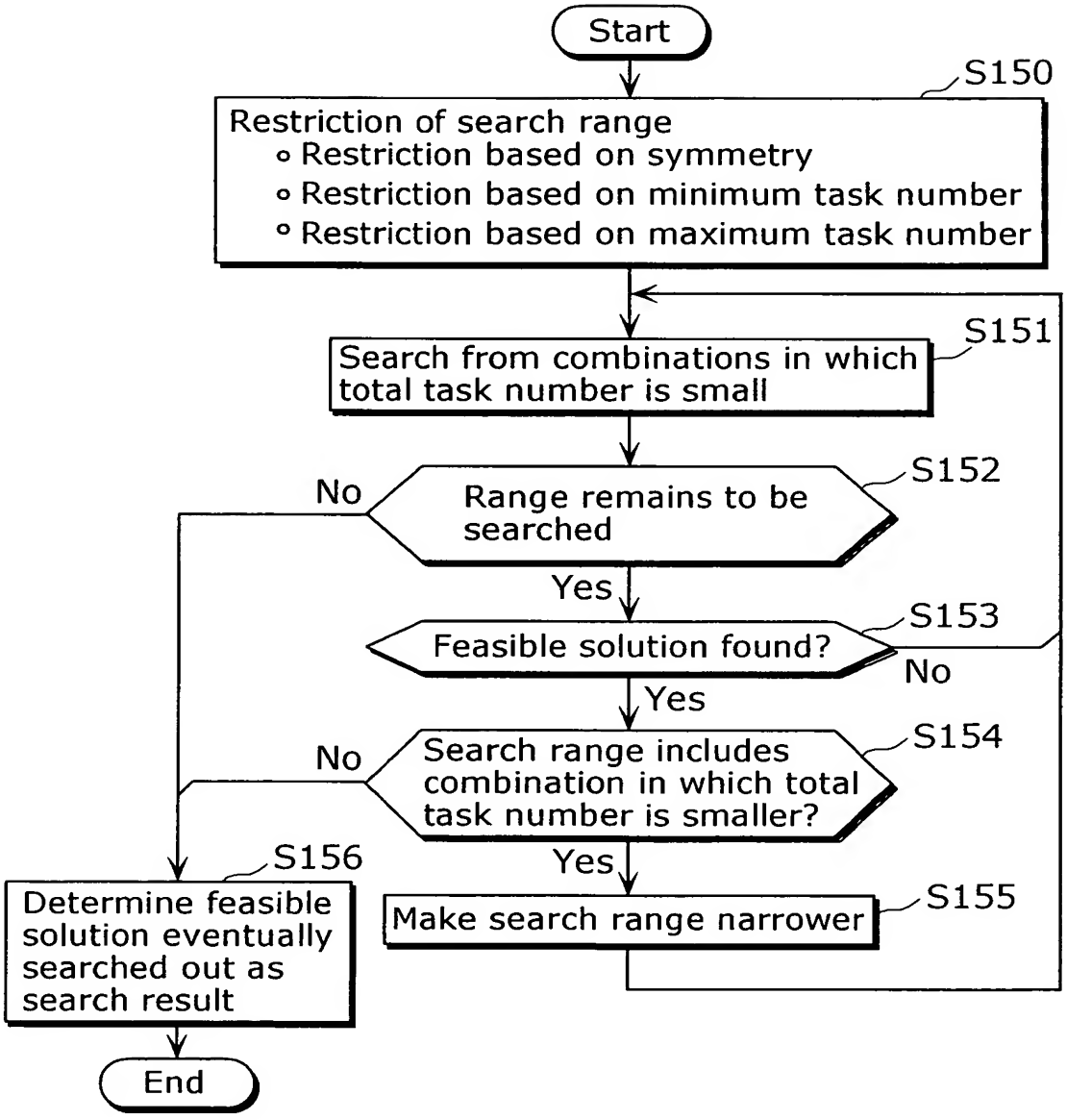

Start
S150
Restriction of search range
∘ Restriction based on symmetry
∘ Restriction based on minimum task number
∘ Restriction based on maximum task number
S151
Search from combinations in which total task number is small
S152
No
Range remains to be searched
Yes
S153
Feasible solution found?
No
Yes
S154
No
Search range includes combination in which total task number is smaller?
Yes
S155
Make search range narrower
S156
Determine feasible solution eventually searched out as search result
End

FIG. 24

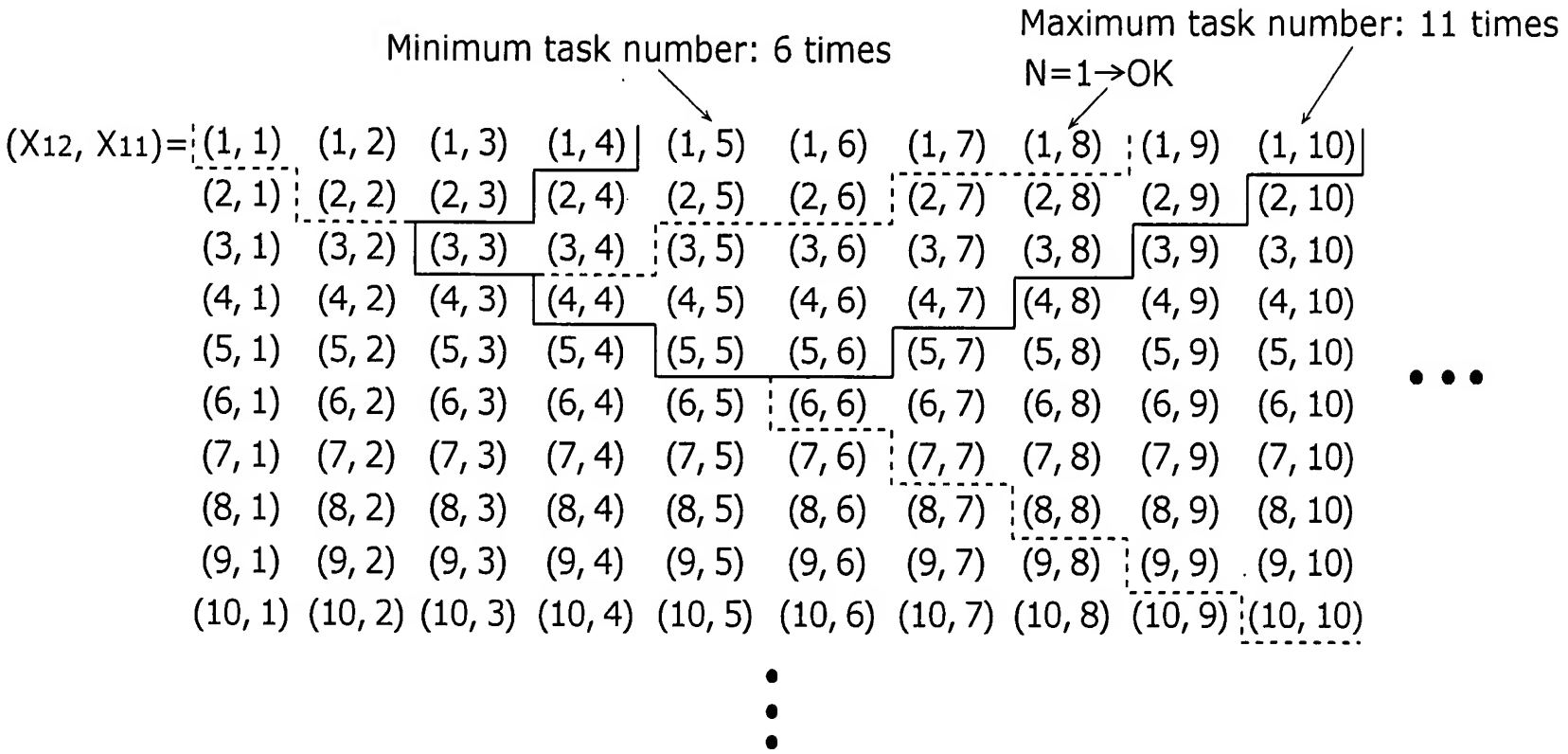


FIG. 25A

Nozzle set

| Nozzle set | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | S(6) | S(6) | S(6) | S(6) |
| 2 | S(1) | S(1) | M(1) | M(1) |
| 3 | M(1) | M(1) | M(1) | L(1) |

FIG. 25B

Nozzle pattern 1 (Number of nozzles to be interchanged: 4)

| Nozzle set | タスクNo. | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|
| 1 | 1～6 | Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| 2 | 7 | Ⓢ | Ⓢ | Ⓜ | Ⓜ |
| 3 | 8 | Ⓜ | Ⓛ | Ⓜ | Ⓜ |

FIG. 25C

Nozzle pattern 2 (Number of nozzles to be interchanged: 6)

| Nozzle set | Task No. | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|
| 1 | 1～6 | Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| 3 | 7 | Ⓜ | Ⓜ | Ⓜ | Ⓛ |
| 2 | 8 | Ⓜ | Ⓜ | Ⓢ | Ⓢ |

FIG. 25D

Nozzle pattern 3 (Number of nozzles to be interchanged: 6)

| Nozzle set | Task No. | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|
| 2 | 1 | Ⓢ | Ⓢ | Ⓜ | Ⓜ |
| 1 | 2～7 | Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| 3 | 8 | Ⓜ | Ⓜ | Ⓜ | Ⓛ |

FIG. 26A

Nozzle pattern

| Nozzle set | Task No. | H1 | H2 | H3 | H4 |
|---|---|---|---|---|---|
| 1 | 1～6 | Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| 2 | 7 | Ⓢ | Ⓢ | Ⓜ | Ⓜ |
| 3 | 8 | Ⓜ | Ⓛ | Ⓜ | Ⓜ |

Nozzle arrangement 1 at nozzle station

FIG. 26B

| | | | |
|---|---|---|---|
| Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| Ⓢ | Ⓢ | Ⓜ | Ⓜ |
| Ⓜ | Ⓛ | Ⓜ | Ⓜ |

Nozzle arrangement 2 at nozzle station

FIG. 26C

| | | | |
|---|---|---|---|
| Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| ◌ | ◌ | Ⓜ | Ⓜ |
| Ⓜ | Ⓛ | ◌ | ◌ |

Nozzle arrangement 3 at nozzle station

FIG. 26D

| | | | |
|---|---|---|---|
| Ⓢ | Ⓢ | Ⓢ | Ⓢ |
| Ⓜ | Ⓛ | Ⓜ | Ⓜ |

FIG. 27

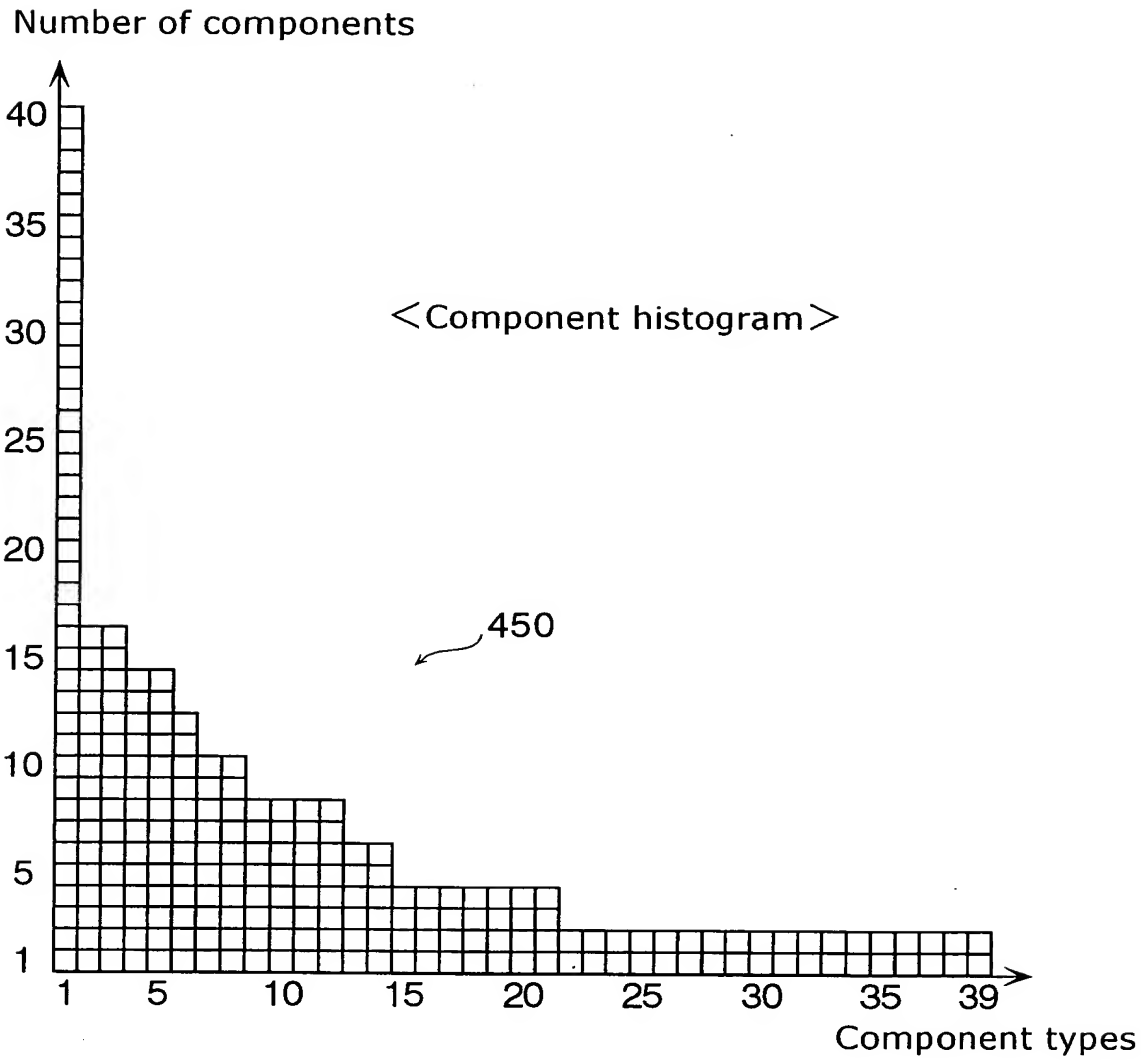

Number of components
40
35
30
25
20
15
10
5
1
<Component histogram>
450
1
5
10
15
20
25
30
35
39
Component types

FIG. 28

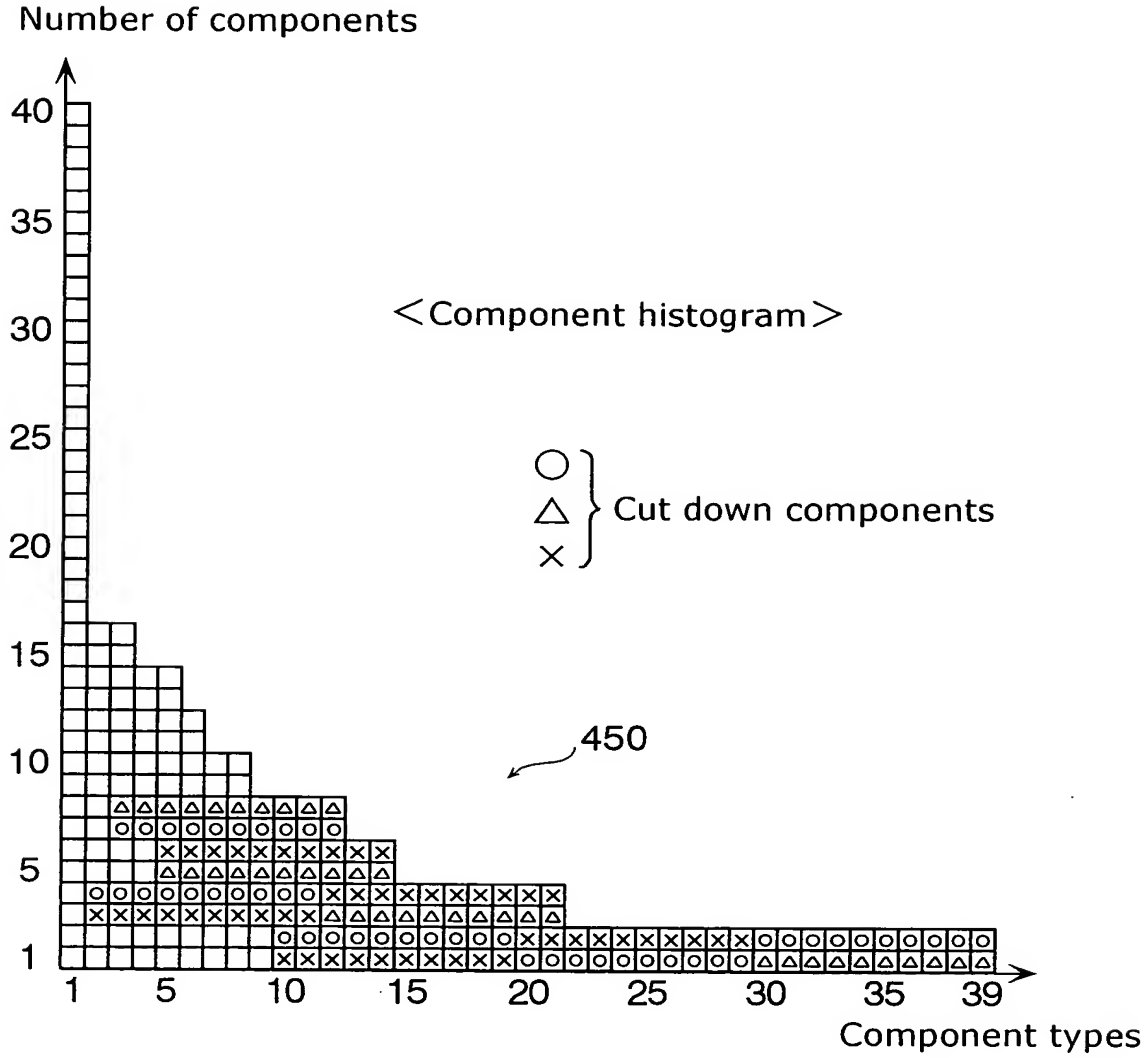

Number of components
40
35
30
25
20
15
10
5
1
<Component histogram>
Cut down components
450
1
5
10
15
20
25
30
35
39
Component types

FIG. 29

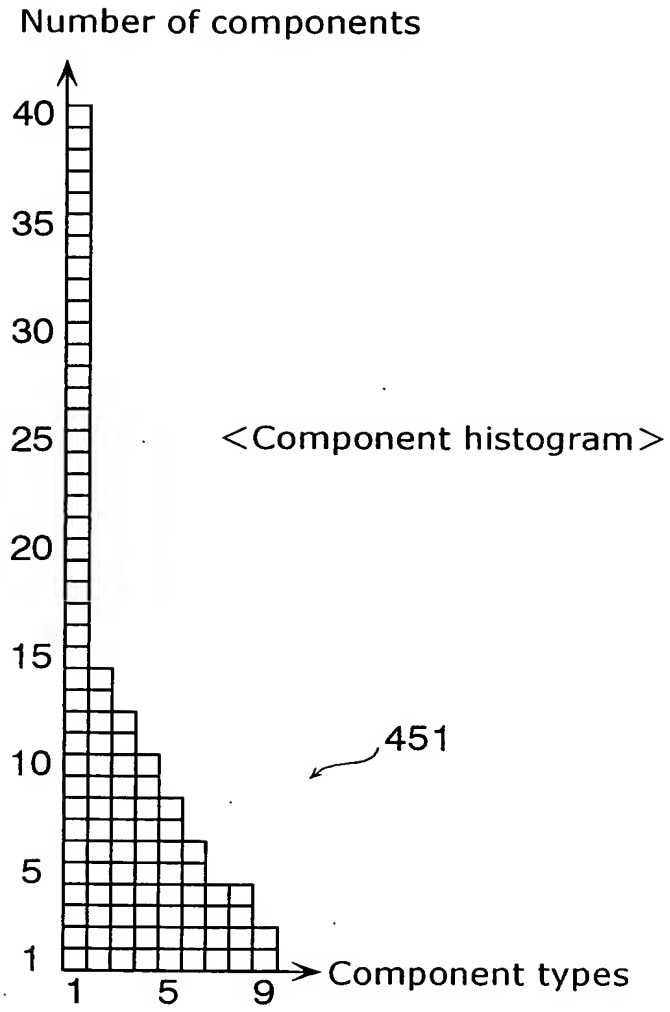

Number of components
40
35
30
25
20
15
10
5
1
<Component histogram>
451
1
5
9
Component types

FIG. 30

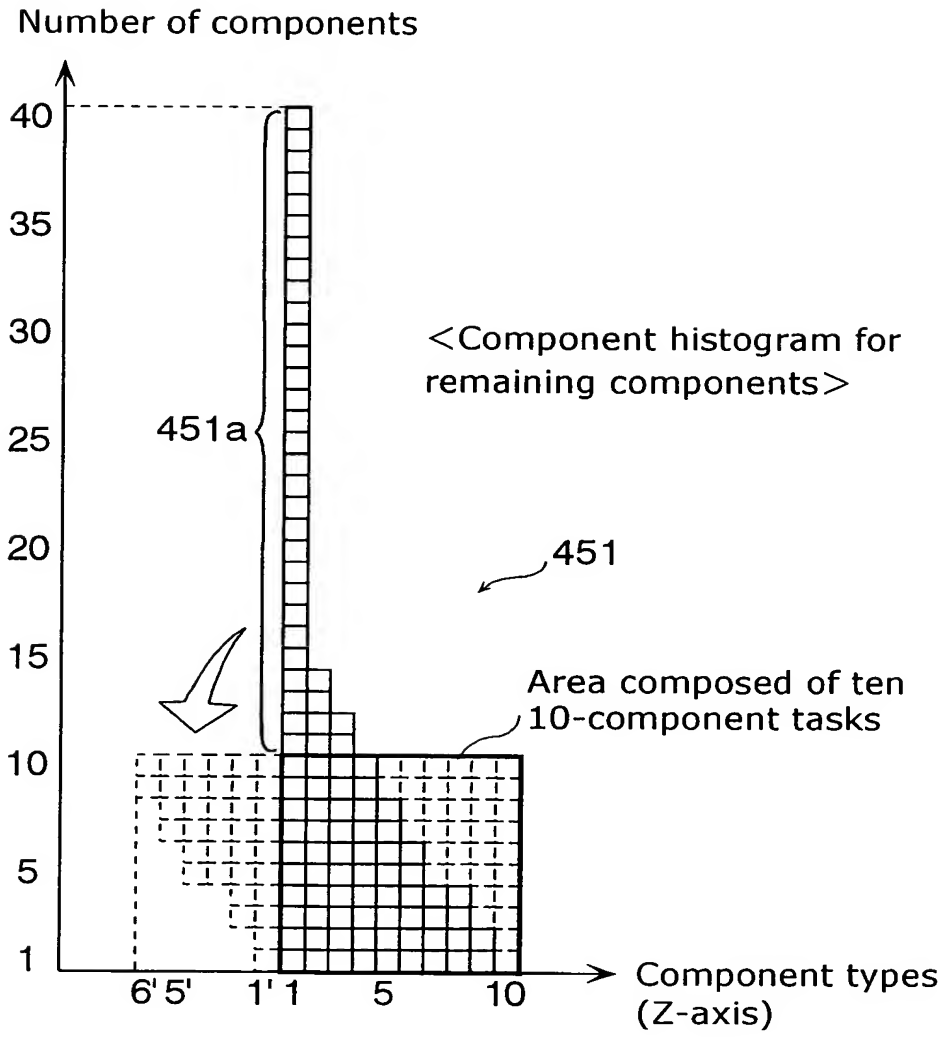

Number of components
40
35
30
25
20
15
10
5
1
451a
<Component histogram for remaining components>
451
Area composed of ten 10-component tasks
6' 5' 1' 1 5 10
Component types (Z-axis)

FIG. 31

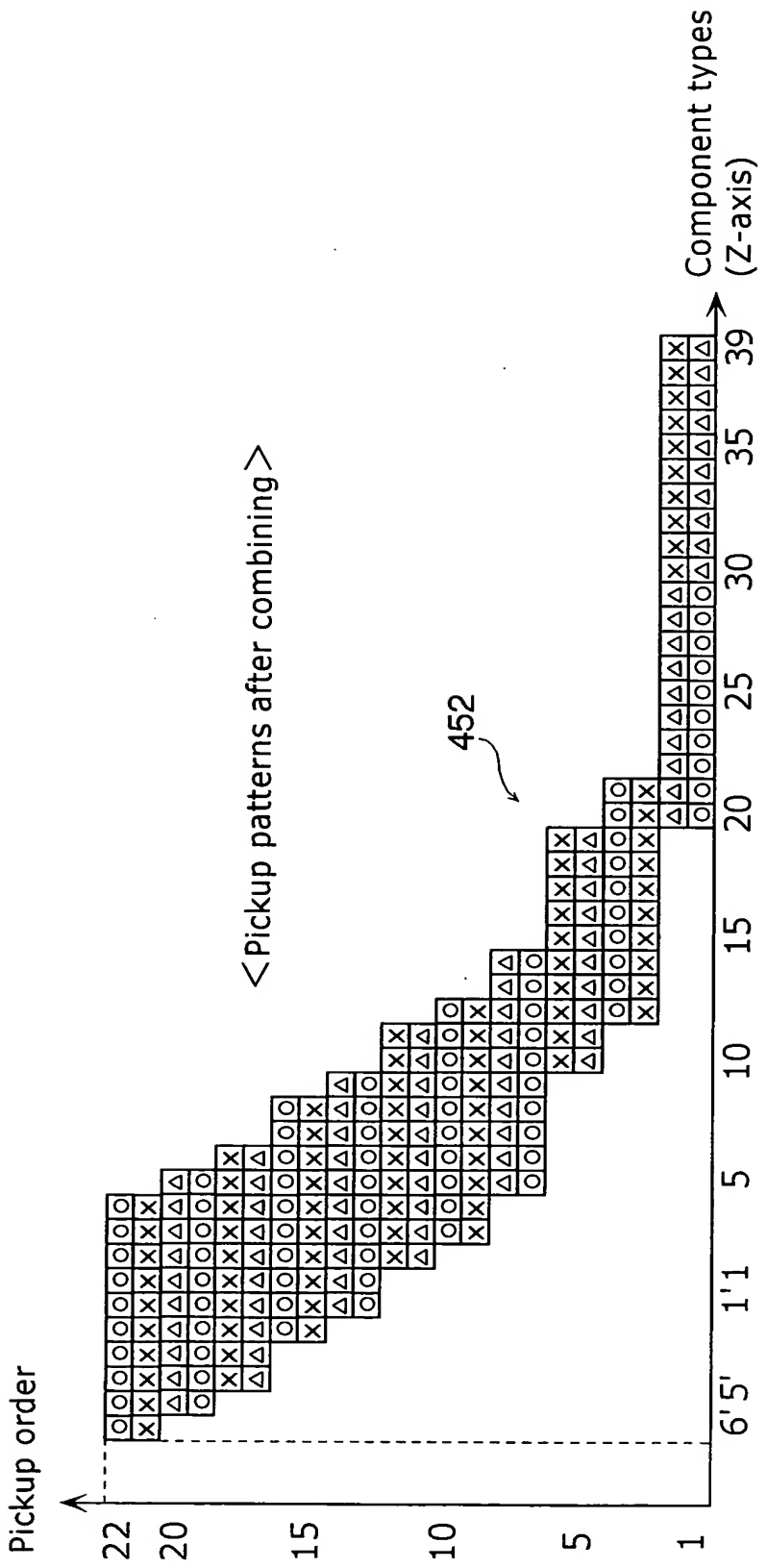

Pickup order
22
20
15
10
5
1
<Pickup patterns after combining>
452
6'5'
1'1
5
10
15
20
25
30
35
39
Component types
(Z-axis)

FIG. 32

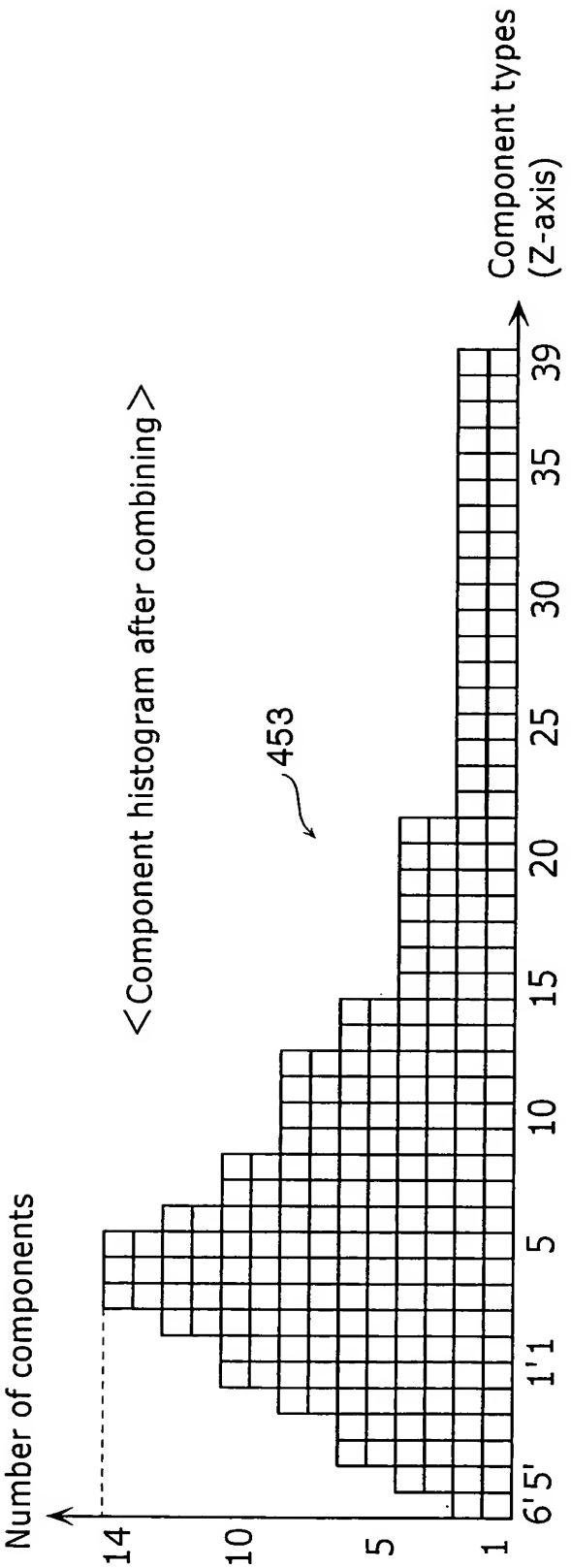

Component types
(Z-axis)
39
35
30
25
20
15
10
5
1'1
6'5'
Number of components
14
10
5
1
<Component histogram after combining>
453

FIG. 33A

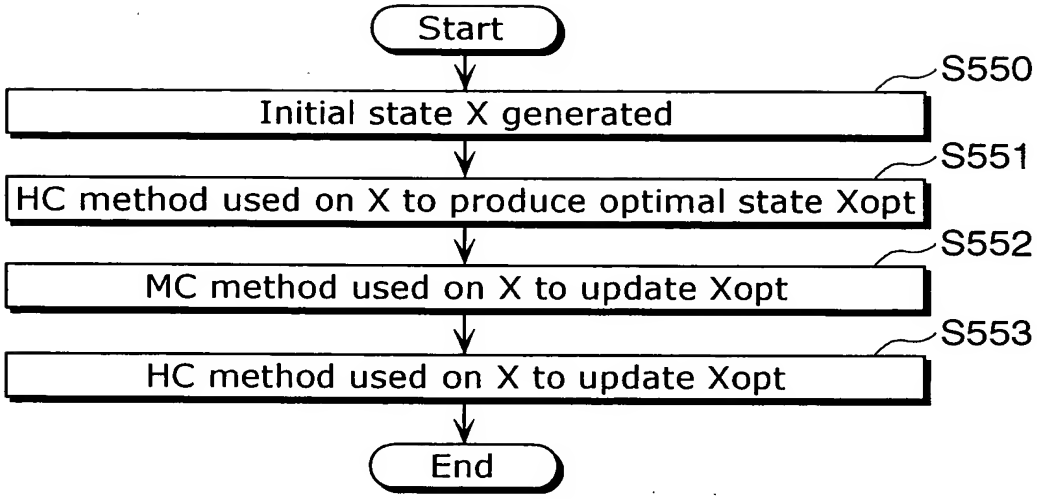



FIG. 33B

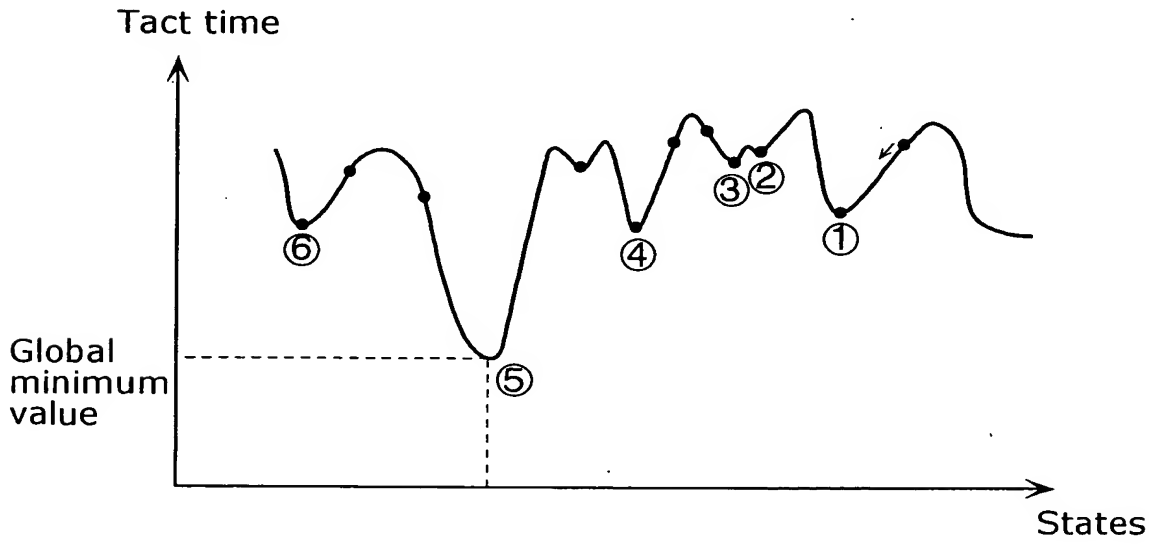


FIG. 34

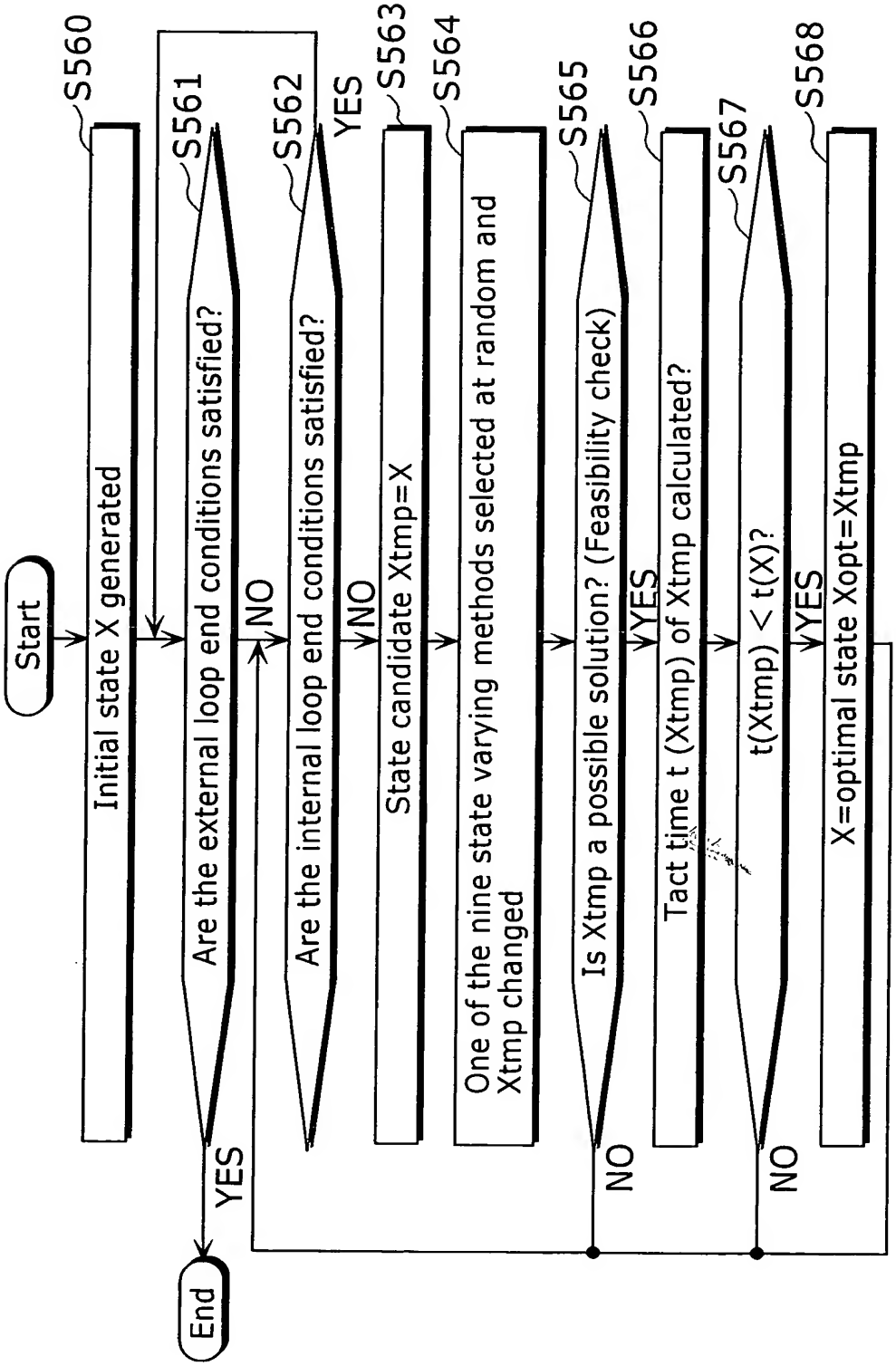

Start
Initial state X generated
S560
Are the external loop end conditions satisfied?
S561
YES
End
NO
Are the internal loop end conditions satisfied?
S562
YES
NO
State candidate Xtmp=X
S563
One of the nine state varying methods selected at random and Xtmp changed
S564
Is Xtmp a possible solution? (Feasibility check)
S565
YES
NO
Tact time t (Xtmp) of Xtmp calculated?
S566
t(Xtmp) < t(X)?
S567
YES
NO
X=optimal state Xopt=Xtmp
S568

FIG. 35

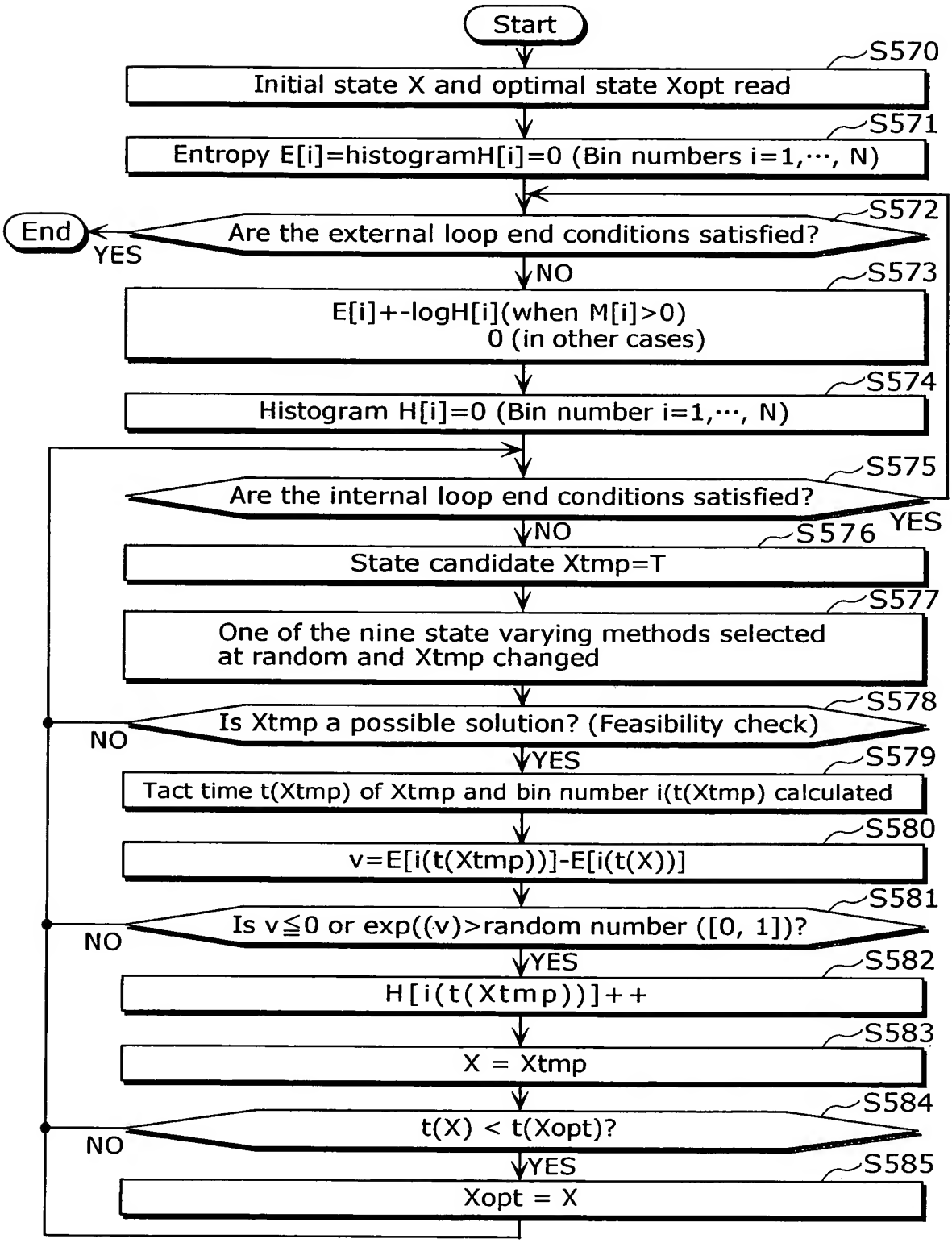

Start
S570
Initial state X and optimal state Xopt read
S571
Entropy E[i]=histogramH[i]=0 (Bin numbers i=1,···, N)
S572
Are the external loop end conditions satisfied?
End
YES
NO
S573
E[i]+-logH[i](when M[i]>0)
0 (in other cases)
S574
Histogram H[i]=0 (Bin number i=1,···, N)
S575
Are the internal loop end conditions satisfied?
YES
NO
S576
State candidate Xtmp=T
S577
One of the nine state varying methods selected at random and Xtmp changed
S578
Is Xtmp a possible solution? (Feasibility check)
NO
YES
S579
Tact time t(Xtmp) of Xtmp and bin number i(t(Xtmp) calculated
S580
v=E[i(t(Xtmp))]-E[i(t(X))]
S581
Is v≦0 or exp((v)>random number ([0, 1])?
NO
YES
S582
H[i(t(Xtmp))]++
S583
X = Xtmp
S584
t(X) < t(Xopt)?
NO
YES
S585
Xopt = X

FIG. 36

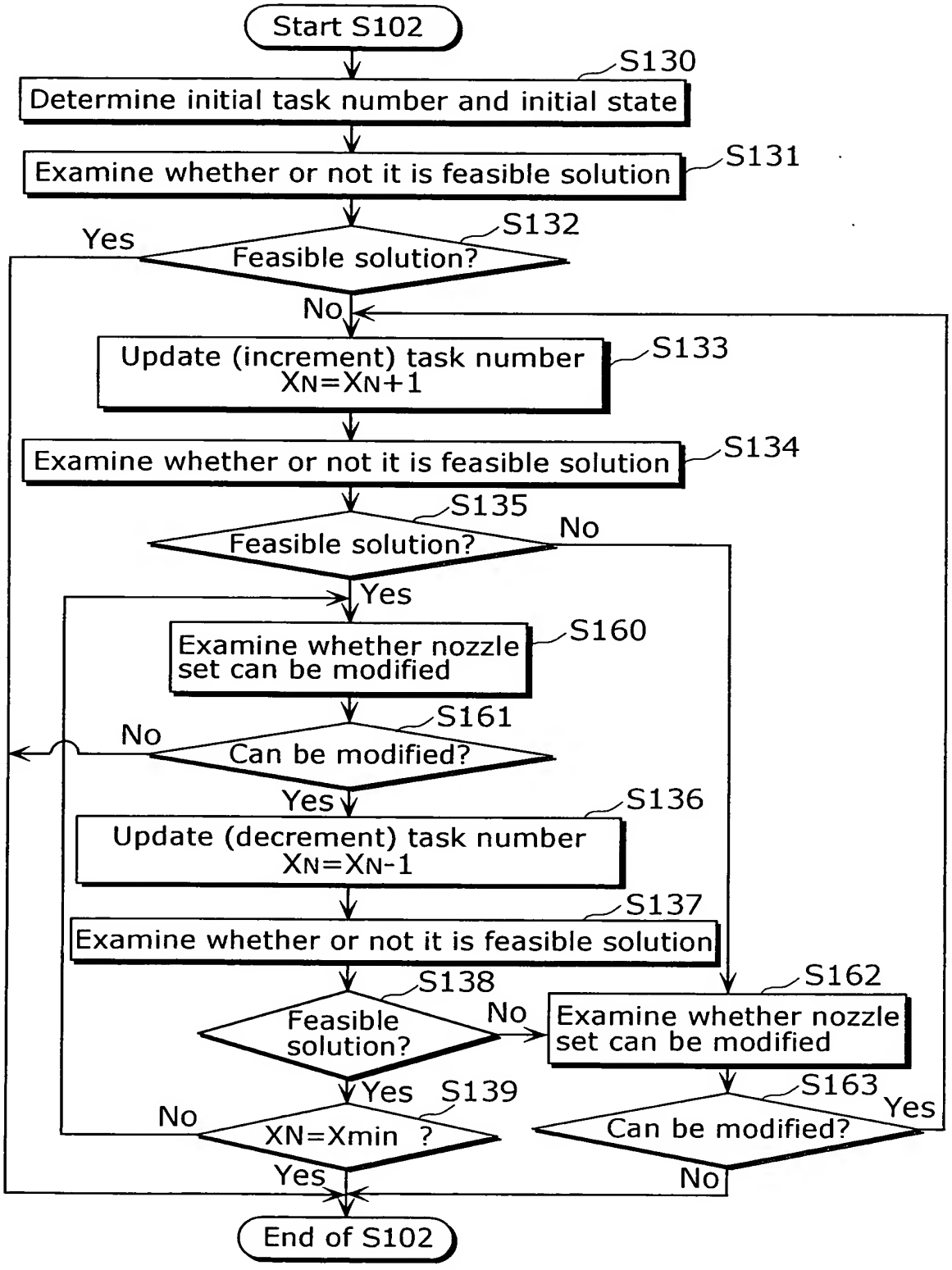

Start S102
S130
Determine initial task number and initial state
Examine whether or not it is feasible solution
S131
S132
Feasible solution?
Yes
No
Update (increment) task number
XN=XN+1
S133
Examine whether or not it is feasible solution
S134
S135
Feasible solution?
No
Yes
Examine whether nozzle set can be modified
S160
S161
Can be modified?
No
Yes
Update (decrement) task number
XN=XN-1
S136
Examine whether or not it is feasible solution
S137
S138
Feasible solution?
No
Yes
S139
XN=Xmin ?
No
Yes
S162
Examine whether nozzle set can be modified
S163
Can be modified?
Yes
No
End of S102

FIG. 37

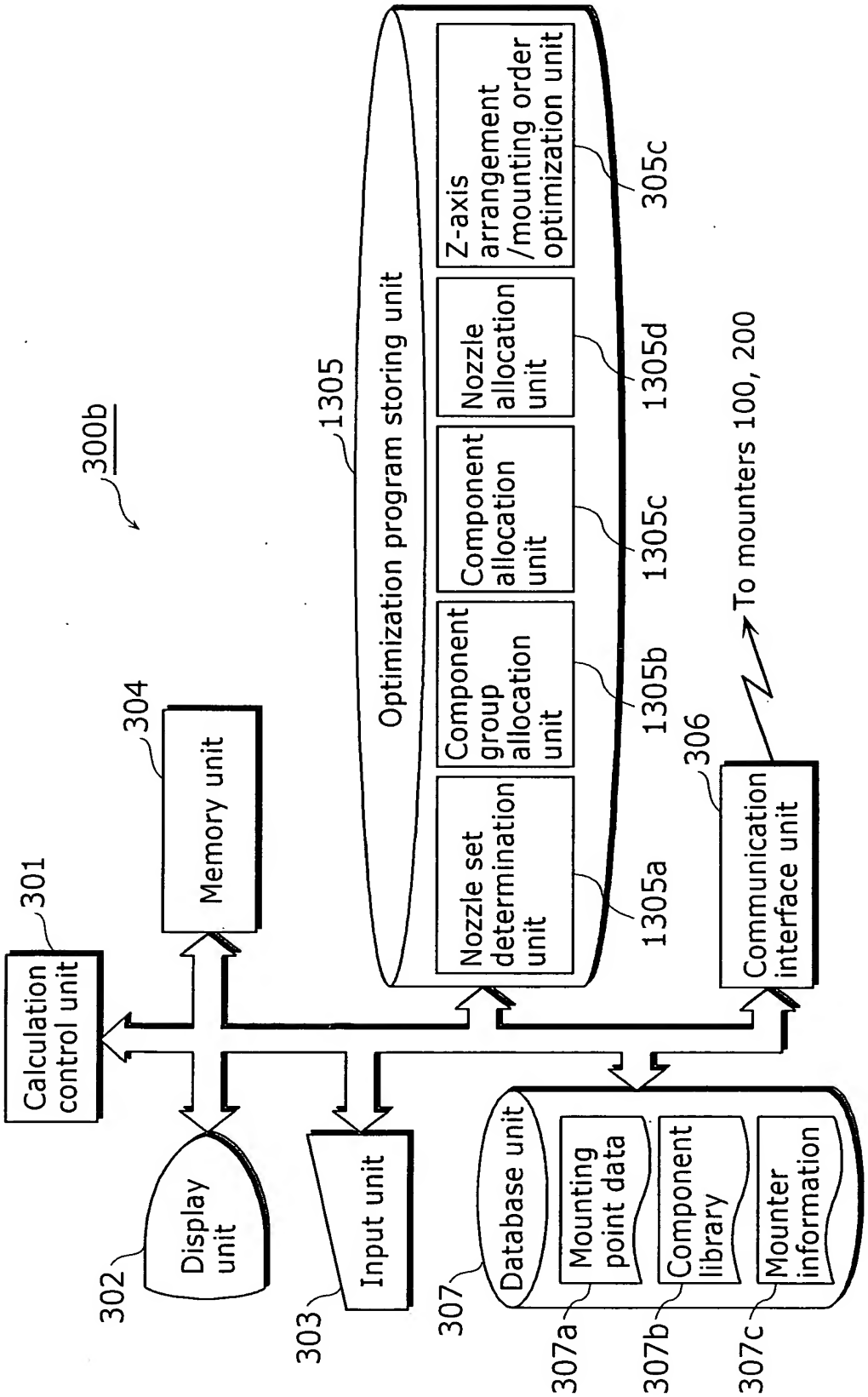

300b
1305
Optimization program storing unit
Z-axis arrangement /mounting order optimization unit
305c
Nozzle allocation unit
1305d
Component allocation unit
1305c
Component group allocation unit
1305b
Nozzle set determination unit
1305a
304
Memory unit
306
Communication interface unit
To mounters 100, 200
301
Calculation control unit
Display unit
302
Input unit
303
307
Database unit
Mounting point data
307a
Component library
307b
Mounter information
307c

FIG. 38

| Component group | Component thickness(Tmm) | Nozzle type | Supply method |
|---|---|---|---|
| PG1 | 0<T≦0.25 | SX | cassette |
| PG2 | 0.25<T≦0.3 | SA | cassette |
| PG3 | 0.3<T≦0.35 | S,M | cassette |
| PG4 | 0.35<T≦0.4 | S,M | cassette |
| PG5 | 0.5<T≦4 | M | cassette |
| PG6 | 0<T≦4 | L | — |
| PG7 | 0<T≦4 | L | — |
| PG8 | 4<T≦25 | — | — |
| PG9 | 4<T≦25 | — | — |

FIG. 39

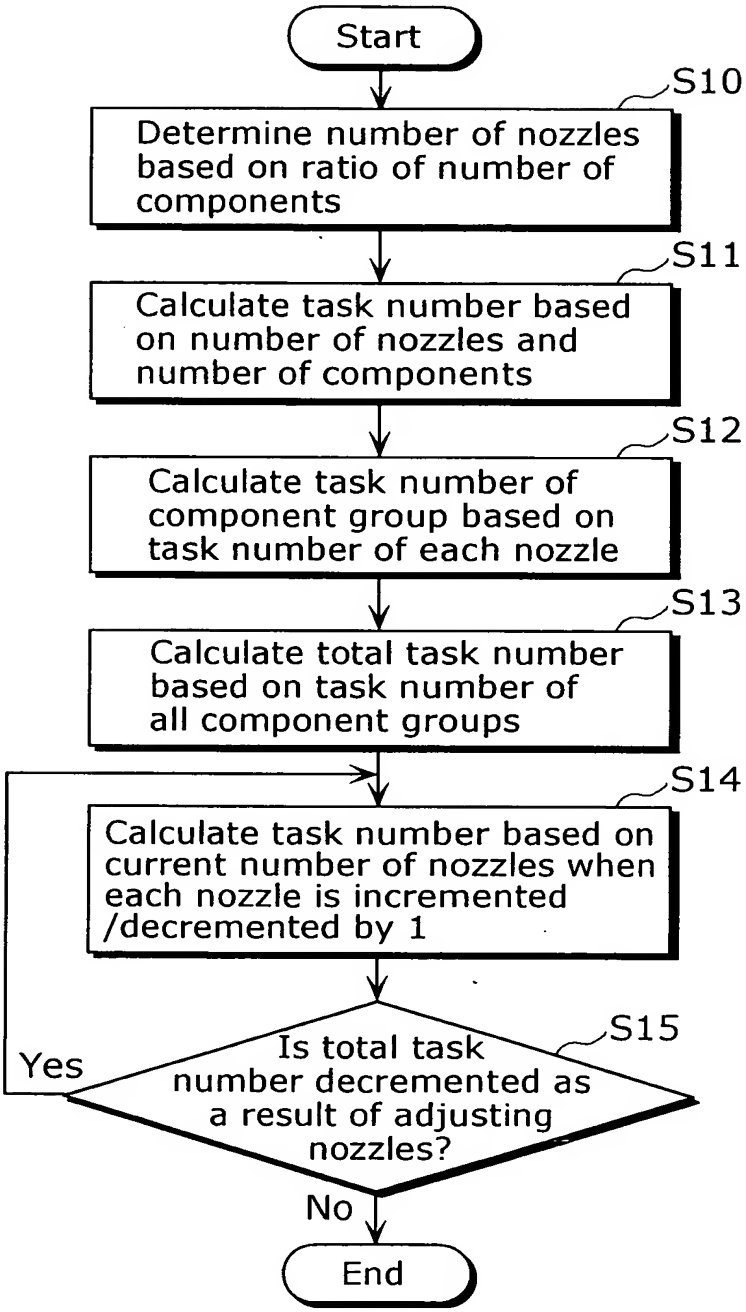

Start
S10
Determine number of nozzles based on ratio of number of components
S11
Calculate task number based on number of nozzles and number of components
S12
Calculate task number of component group based on task number of each nozzle
S13
Calculate total task number based on task number of all component groups
S14
Calculate task number based on current number of nozzles when each nozzle is incremented /decremented by 1
S15
Is total task number decremented as a result of adjusting nozzles?
Yes
No
End

FIG. 40

| Component type | 0603 | 1005 |
|---|---|---|
| Number of components | 19 | 45 |
| Nozzle type | SX | SA |
| PG | 1 | 2 |

FIG. 41

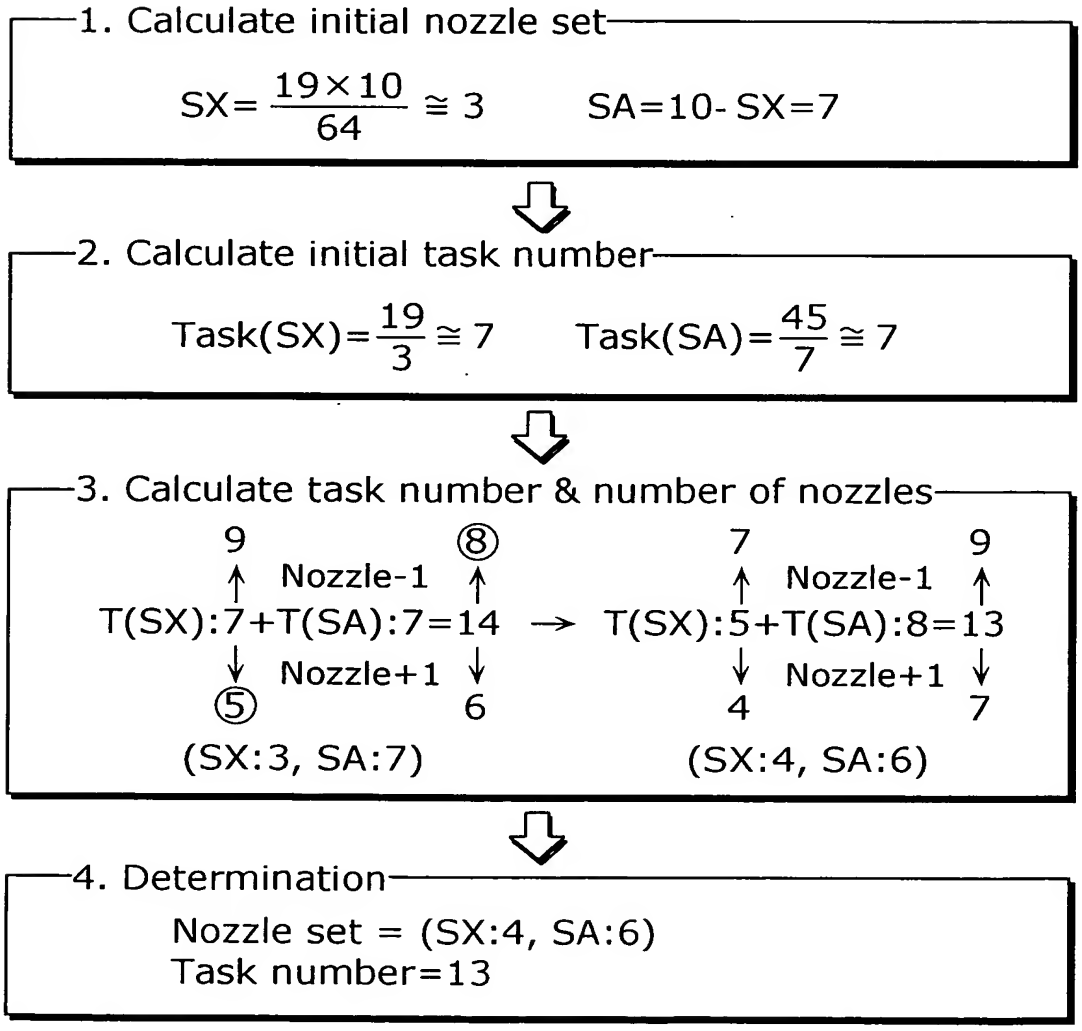


FIG. 42

| Component type | 1CAP | 3CAP |
|---|---|---|
| Number of components | 43 | 19 |
| Nozzle type | S | M |
| PG | 3 | |

FIG. 43

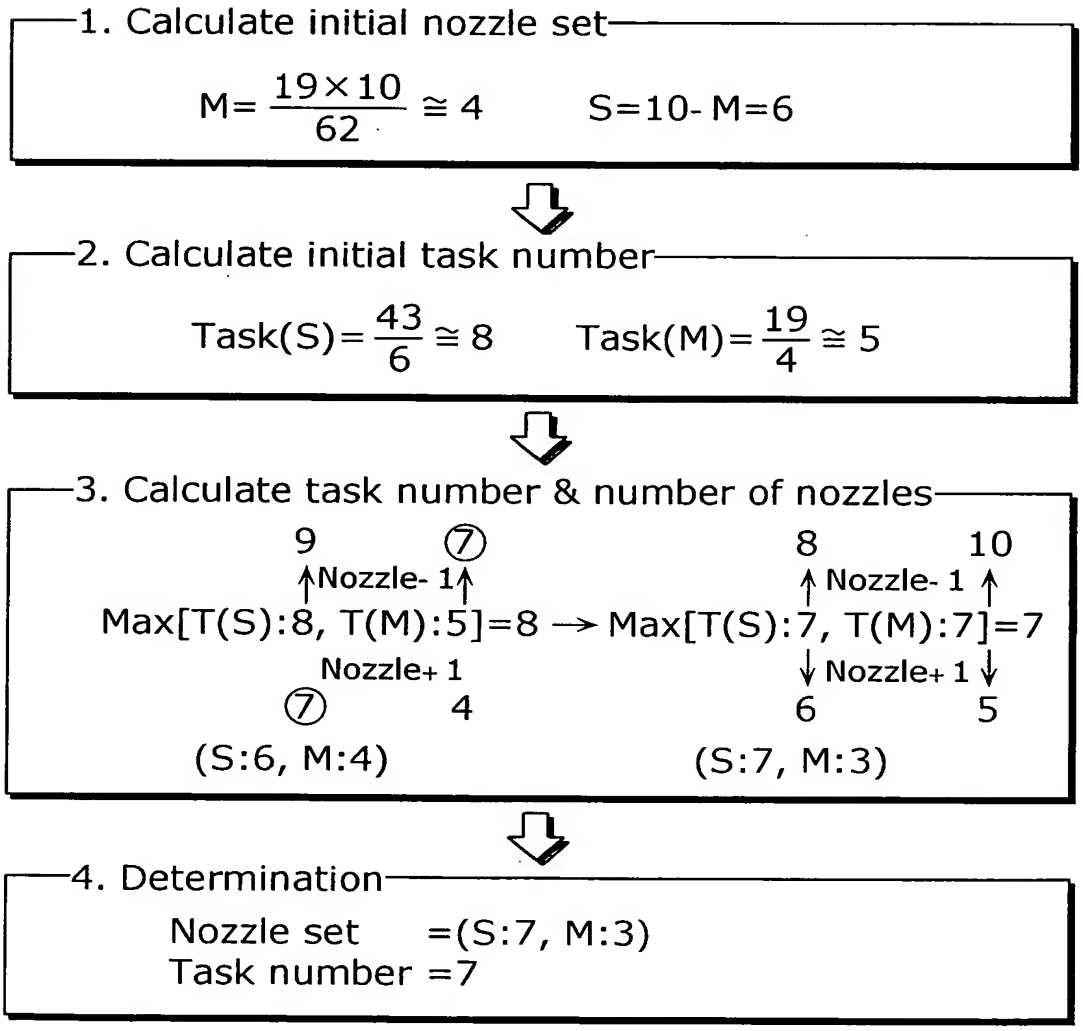


FIG. 44

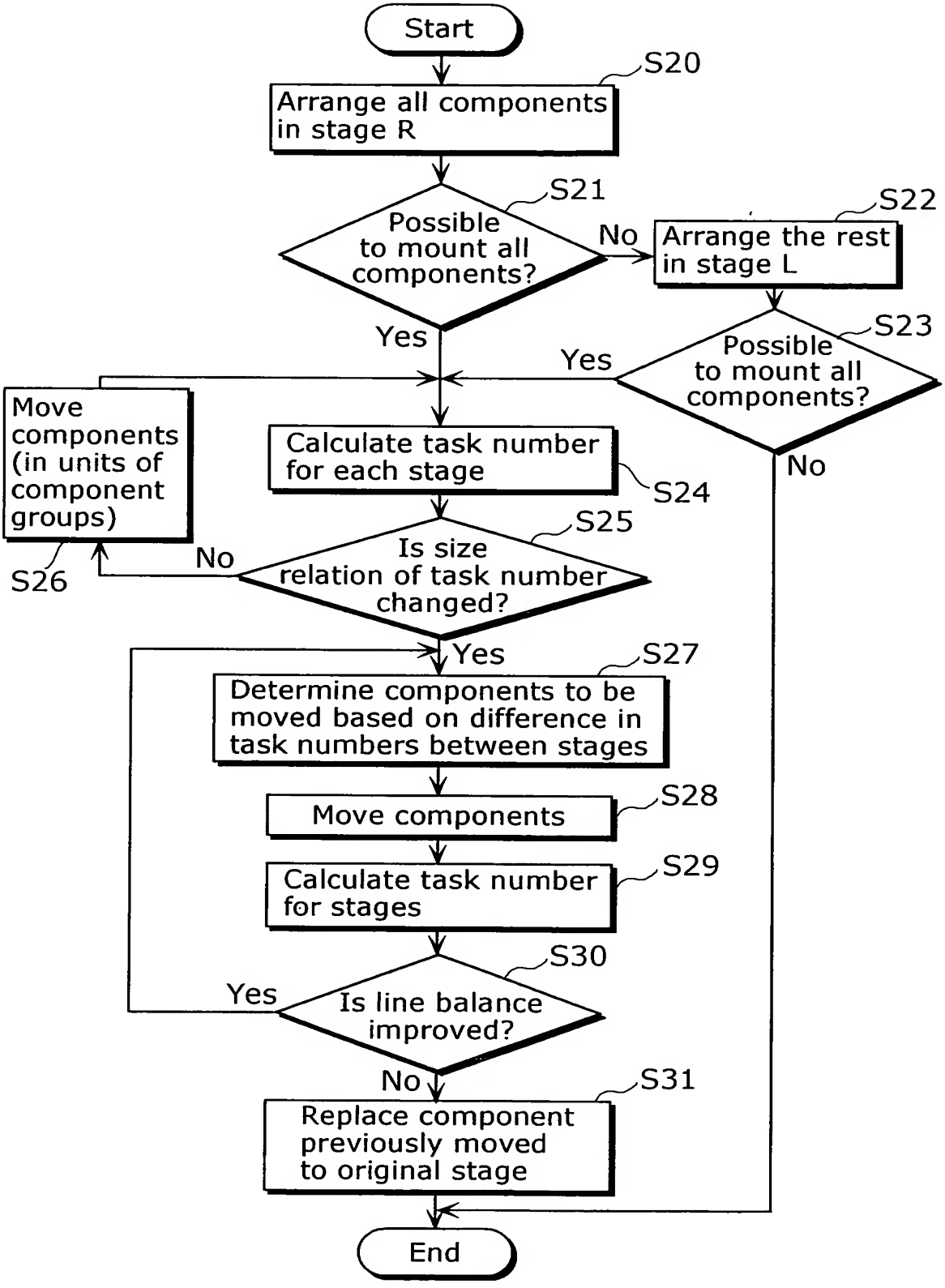

Start
S20
Arrange all components in stage R
S21
Possible to mount all components?
No
S22
Arrange the rest in stage L
Yes
S23
Possible to mount all components?
Yes
No
Move components (in units of component groups)
Calculate task number for each stage
S24
S25
Is size relation of task number changed?
No
S26
Yes
S27
Determine components to be moved based on difference in task numbers between stages
Move components
S28
Calculate task number for stages
S29
S30
Is line balance improved?
Yes
No
S31
Replace component previously moved to original stage
End

FIG. 45

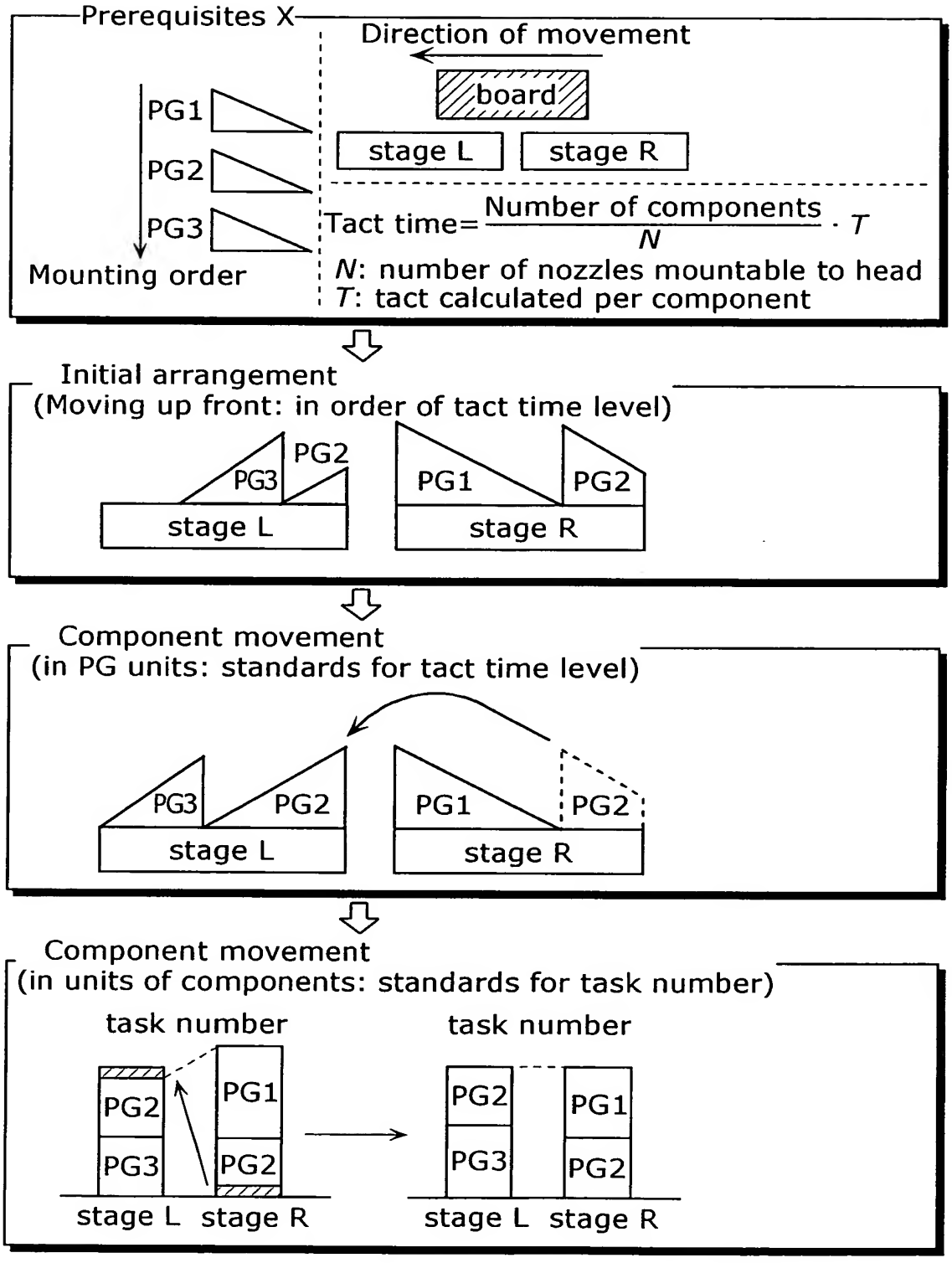
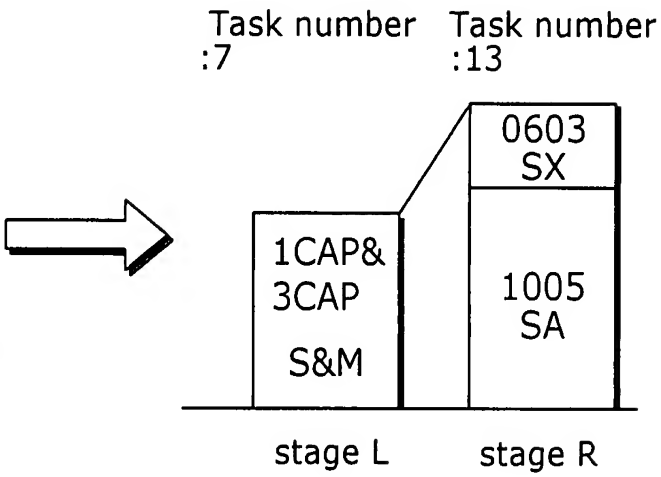

Prerequisites X
Direction of movement
board
PG1
PG2
PG3
stage L
stage R
Tact time= Number of components / N · T
Mounting order
N: number of nozzles mountable to head
T: tact calculated per component
Initial arrangement
(Moving up front: in order of tact time level)
PG3
PG2
PG1
PG2
stage L
stage R
Component movement
(in PG units: standards for tact time level)
PG3
PG2
PG1
PG2
stage L
stage R
Component movement
(in units of components: standards for task number)
task number
task number
PG2
PG1
PG3
PG2
PG2
PG1
PG3
PG2
stage L
stage R
stage L
stage R

FIG. 46

| Component type | 0603 | 1005 | 1CAP | 3CAP |
|---|---|---|---|---|
| Number of components | 19 | 45 | 43 | 19 |
| Nozzle type | SX | SA | S | M |
| PG | 1 | 2 | 3 | |
| Stage | R | | L | |

(a)




(b)

FIG. 47

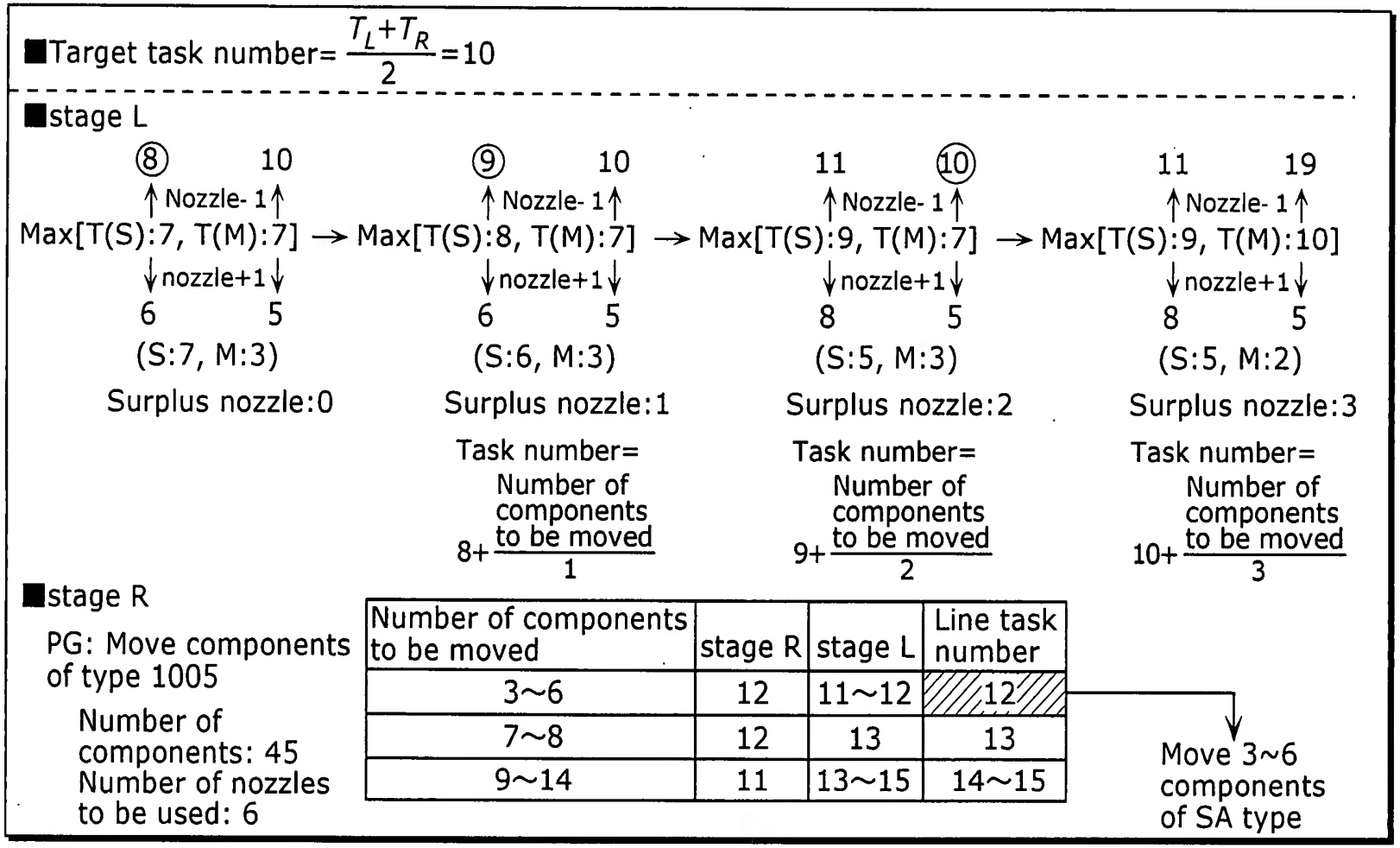


FIG. 48

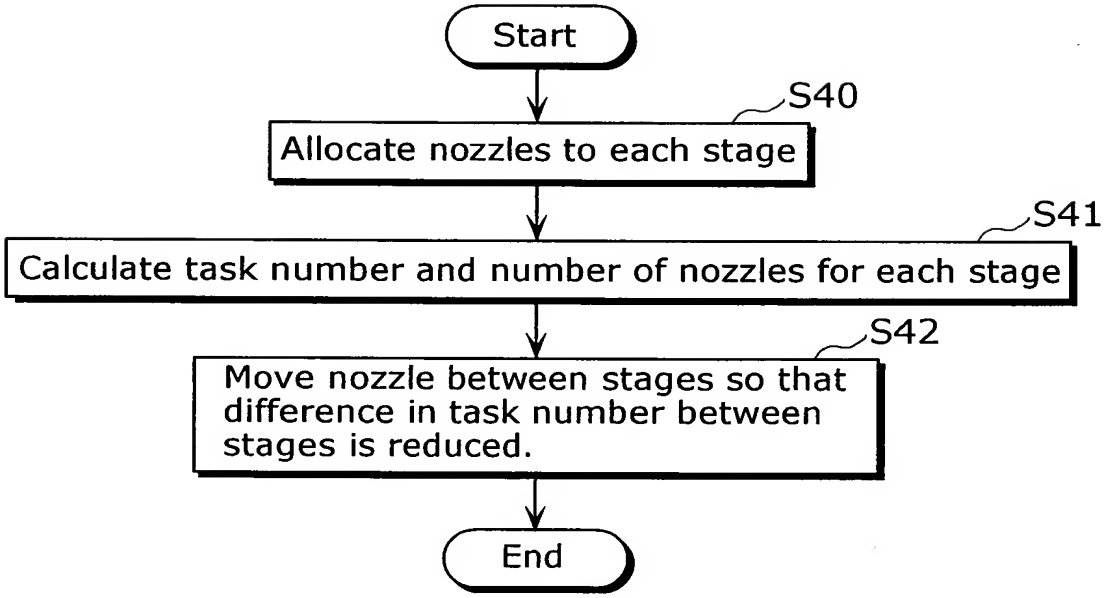

Start
S40
Allocate nozzles to each stage
S41
Calculate task number and number of nozzles for each stage
S42
Move nozzle between stages so that difference in task number between stages is reduced.
End

FIG. 49

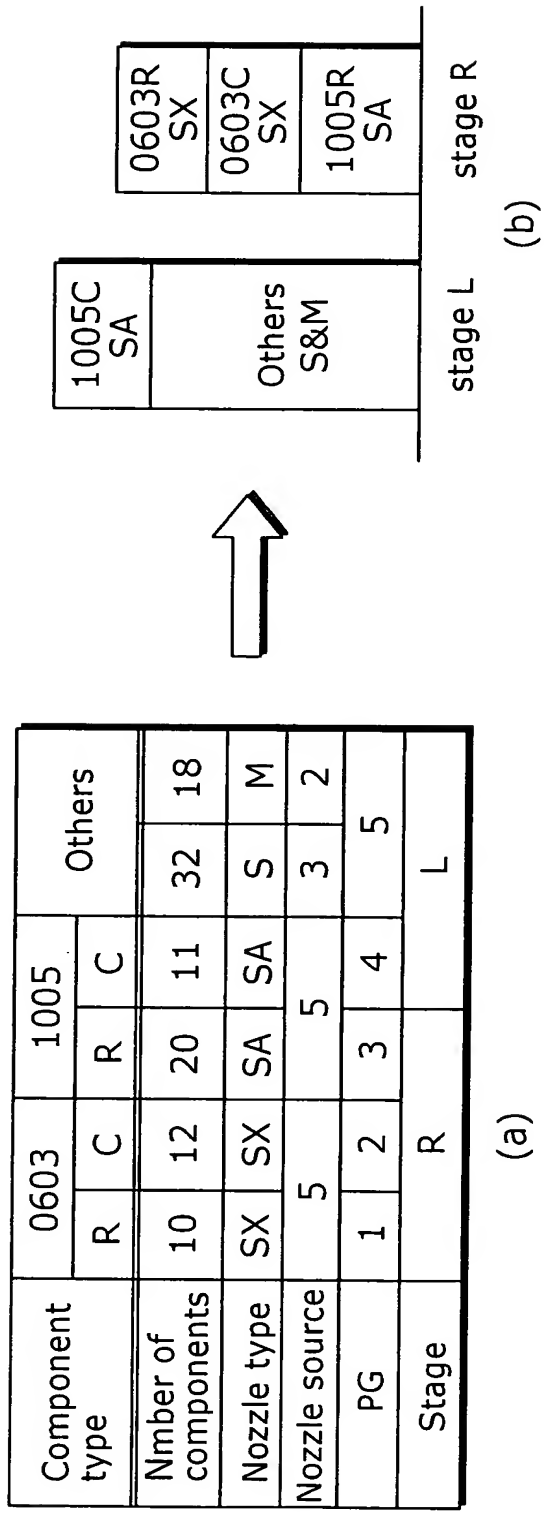

Component type
0603
1005
Others
R
C
R
C
Nmber of components
10
12
20
11
32
18
Nozzle type
SX
SX
SA
SA
S
M
Nozzle source
5
5
3
2
PG
1
2
3
4
5
Stage
R
L
(a)
1005C SA
Others S&M
0603R SX
0603C SX
1005R SA
stage L
stage R
(b)

FIG. 50